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OPERATING AND SERVICE MANUAL

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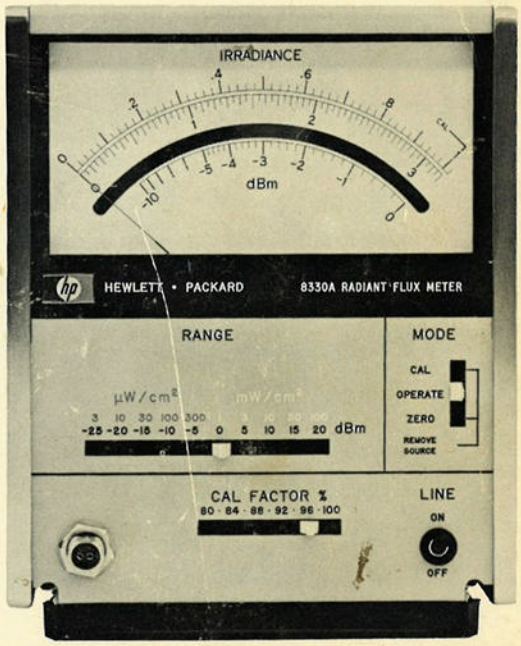
RADIANT FLUX METER

8330A



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HP 8330A

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RADIANT FLUX METER
8330A

Serial Numbers Prefixed: 1046-

This manual applies directly to HP Model 8330A Meters having serial prefix number 1046-.

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1501 PAGE MILL ROAD, PALO ALTO, CALIFORNIA, U.S.A.

HP Part No. 08330-90002

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Figure 1-1. Model 8330A Radiant Flux Meter and Model 8334A Radiant Flux Detector

SECTION I
GENERAL INFORMATION

1-1. DESCRIPTION

1-2. The Hewlett-Packard Model 8330A Radiant Flux Meter (Figure 1-1), when used with the Model 8334A Detector, measures irradiance from 3 μW/cm^2 to 100 mW/cm^2 in 10 overlapping ranges. The radiant flux (total watts) and radiance (watts/cm^2/solid angle) are simultaneously displayed on the front panel meter. The Model 8330A instrumentation uncertainty is ±1% of full-scale and a front panel switch can be used to compensate for different probe efficiencies or transmission factors of lenses and filters.

1-3. The Model 8330A is equipped for internal zeroing on the range in use, and for internal calibration on the 3 mW/cm^2 range. An output is provided for recorder or digital voltmeter readout. Another output is provided to disable the appropriate optical source in the CAL and ZERO modes of operation.

1-4. ACCESSORIES

1-5. A 7.5 foot (2,29m) detachable power cable is supplied with the Model 8330A meter. The Range Calibrator and the Detector are available from Hewlett-Packard, but are not supplied with the Model 8330A meter. Table 1-1 includes specifications, accessories supplied and accessories which are available.

Table 1-1. System Specifications

Ranges:
Ten full-scale ranges of 3, 10, 30, 100, and 300 μW/cm^2, 1, 3, 10, 30, and 100 mW/cm^2.

Wavelength Range:
Depends on specifications of probe. With Model 8334A probe fitted with quartz window, accurate measurements can be made from 0.3 to 3 microns.

System Accuracy:
Maximum absolute uncertainty of broadband irradiance measurement is less than ±5% of full scale on any range, including uncertainty of NBS-traceable calibration standards, transfer calibrations, linearity, and electronic instrumentation over an ambient temperature range of 0–55°C.

System Response Time 10–90%:
Measured at Recorder/Digital Voltmeter output: <70 milliseconds on 3, 10, 30, 100 mW/cm^2 ranges, <0.7 second on 100, 300 μW/cm^2 and 1 mW/cm^2 ranges, <2.7 seconds on 3, 10 30 μW/cm^2 ranges.

Maximum Average Power:
Refer to detector specifications; 1 watt/cm^2 with Model 8334A.

Calibrator:
Automatic, operated by front panel switch.

Zero:
Automatic, operated by front panel switch.

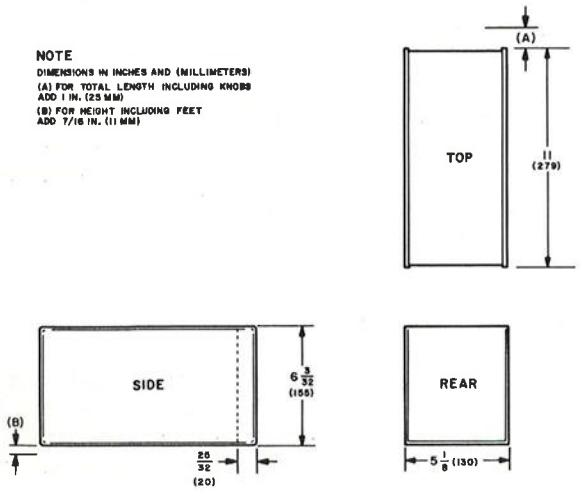
Calibration Factor Control:
Eleven position switch normalizes meter reading to account for calibration factor or to compensate for filter transmission losses, etc. Range is 80% to 100% in 2% steps. A rear panel switch allows range to be extended to cover 60% to 80% in 2% steps.

Recorder Output:
Proportional to indicated power with 1 volt corresponding to full scale; 1000Ω output impedance. BNC connector.

Blanking Output:
Provides contact closure when Cal or Zero mode is selected. Enables control of external source or shutter to interrupt optical input during Cal and Zero modes of operation. BNC connector on rear panel. Maximum current: 100 mA.

Table 1-1. System Specifications (Cont)

Dimensions:



Power:
115 or 230 Vac ±10%, 50 to 400 Hz, 2-1/2 watts.

Weight:
Net, 6 lb, 10 oz (3 kg). Shipping, 9 lb, 8 oz (4,3 kg).

Meter:
Taut-band suspension, individually computer calibrated, mirror-backed scales. Milliwatt scale more than 4.25 inches (108 mm) long.

Accessories Furnished:
7.50 foot (2,29 m) power cable, IEC plug.

Accessories Available:
115 94A Range Calibrator
5060-0797 Rack Adapter Frame (holds three instruments the size of the Model 8330A).
11076A Carrying Case.

Combining Cases:
1051A, 11.25 inches (286 mm) deep.
1052A, 16.375 inches (416 mm) deep.

The combining cases accept the 1/3-module HP instruments for bench use or rack mounting. See 1051A data sheet for details.

SECTION II
INSTALLATION

2-1. INITIAL INSPECTION

2-2. Mechanical Check

2-3. If damage to the shipping carton is evident, ask that the carrier's agent be present when the instrument is unpacked. Inspect the instrument for mechanical damage. Also check the cushioning material for signs of severe stress.

2-4. Performance Checks

2-5. The electrical performance of the Model 8330A should be verified upon receipt. Performance checks suitable for incoming inspection are given in Section IV, Performance Test and Adjustment Procedure.

2-6. Damage Claims

2-7. If the instrument is mechanically damaged in transit, notify the carrier and the nearest Hewlett-Packard field office immediately. A list of field offices is at the back of this manual. Retain the shipping carton and padding material for the carrier's inspection. The field office will arrange for replacement or repair of your instrument without waiting for claim settlements against the carrier.

2-8. Before shipping, this instrument was inspected and found free of mechanical and electrical defects. If there is any deficiency, or if electrical performance is not within specifications, notify your nearest Hewlett-Packard Sales and Service Office.

2-9. THREE-CONDUCTOR POWER CABLE

2-10. To protect operating personnel, the National Electrical Manufacturers Association (NEMA) recommends that the instrument panel and cabinet be grounded. All Hewlett-Packard instruments are equipped with a three-conductor power cable which, when plugged into an appropriate receptacle, grounds the instrument. The offset pin on the power cable three-prong connector is the ground wire.

2-11. To preserve the protection feature when operating the instrument from a two-connector outlet, use a three-prong to two-prong adapter and connect the green pigtail on the adapter to ground.

2-12. PRIMARY POWER REQUIREMENTS

2-13. The Model 8330A operates from 115 or 230 volts ac line voltage. Line frequency may vary from 50 to 400 Hz. A slide switch on the rear panel is moved to the correct position for the line voltage available. Before operating the equipment, ensure that the fuse installed in the instrument corresponds to the value marked on the panel for the line voltage available (.125 amp slo-blow).

2-14. RACK MOUNTING

2-15. Model 8330A is narrower than the full rack width; it is a submodular unit. When used alone, the instrument can be bench mounted. When used in combination with other submodular units it can be bench or rack-mounted. The HP Model 1051A and Model 1052A Combining Cases and Rack Adapter Frames are designed specifically for this purpose.

2-16. Adapter Frames

2-17. The Model 5060-0797 Adapter Frame is shown in Figure 2-1. The frame will accept a

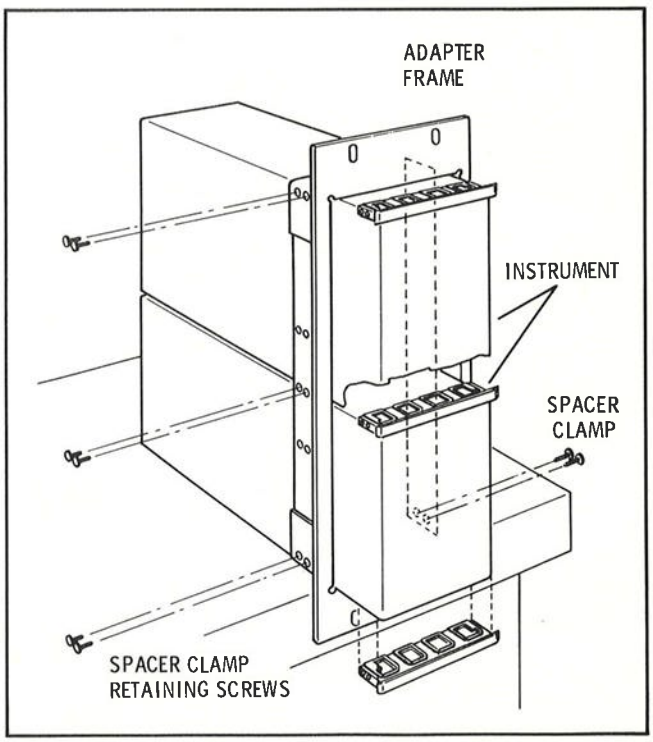


Figure 2-1. Submodule Installation in Rack Adapter Frame

variety of submodular units in a manner suitable for rack mounting. Submodular units, in combination with any necessary spacers are assembled within the frame. A submodular unit cannot be removed individually.

2-18. REPACKING FOR SHIPMENT

2-19. When returning an instrument to Hewlett-Packard, use the original packing material. If the original foam type packing material is not available, contact an authorized HP Sales Office for assistance. If this is not possible, first protect the instrument surfaces by wrapping in heavy kraft paper or with sheets of cardboard flat against the instrument. Protect the instrument on all sides using approximately 4 inches of packing material and pack in a durable container. Mark the container clearly for proper handling and insure adequately before shipping.

2-20. When an instrument is returned to HP for service or repair, attach a tag to the instrument specifying the owner and desired action. All correspondence should identify the instrument by model number and full ten digit serial number.

SECTION III
OPERATING INFORMATION

3-1. INTRODUCTION

3-2. The Model 8330A Radiant Flux Meter operates with a Model 8334A Radiant Flux Detector. The wavelength range of the Detector is dependent on the material used for the window. Quartz, which is supplied with the standard probe, permits accurate measurements from 0.3μ to 3μ. Full-scale power ranges are 3 $\mu W/cm^2$ to 100 mW/cm^2. The total measurement capacity of the instrument is divided into ten ranges which are selected by the front panel RANGE switch.

3-3. CONTROLS, CONNECTORS, AND INDICATORS

3-4. The front and rear panel controls, connectors, and indicators are identified in Figure 3-1. Identification is keyed to corresponding numbers indicated in the figure.

3-5. FUNCTIONS OF CONTROLS, CONNECTORS, AND INDICATORS

3-6. The RANGE control sets the internal amplification of the instrument to extend the range of the meter. The RANGE control also selects the amplifier bandwidth of approximately 0.3 Hz for the 3, 10 and 30 $\mu W/cm^2$ ranges, 1.5 Hz for the 100, 300 $\mu W/cm^2$ and 1 mW/cm^2 and 10 Hz for the remaining ranges. The narrow bandwidth reduces the noise level for convenience in making accurate readings on the lowest ranges.

Note

Response time of the instrument varies with bandwidth. Response time is approximately 2.7 seconds for a bandwidth of 0.3 Hz, 0.7 seconds for a bandwidth of 1.5 Hz, and 70 milliseconds for a bandwidth of 10 Hz.

3-7. The CAL. FACTOR % SWITCH provides discrete amounts of compensation for probe sensitivity changes due to insertion of filters, lenses, and for sensitivity changes when different probes are used.

3-8. When the MODE switch is placed in the CAL position, the internal switching circuits are automatically switched to the 3 mW/cm^2 position independent of the position of the front panel RANGE switch. When the MODE switch moves from the ZERO or CAL position back to the OPERATE mode, the internal switching circuits are set to coincide with the position of the front panel RANGE switch.

3-9. The rear panel RECORDER OUTPUT provides an output voltage linearly proportional to the meter reading; one volt into an open circuit equals full-scale meter deflection. This voltage is developed across a 1K resistor in series with the output. Loading of the RECORDER OUTPUT has no effect on the accuracy of the Model 8330A front panel meter.

Note

Full-scale meter deflection is to the CAL point on the face of the meter.

3-10. A digital voltmeter can be connected to the rear panel RECORDER OUTPUT for better resolution of power meter readings. When a digital voltmeter with an input impedance greater than 1 megohm is connected to the RECORDER OUTPUT, 1 volt equals full-scale deflection. The SOURCE BLANKING output can be used to remove optical power from the probe during the CAL and ZERO modes of operation. In these two modes, a ground connection is made available at the output.

3-11. Figure 3-2 outlines turn-on procedures.

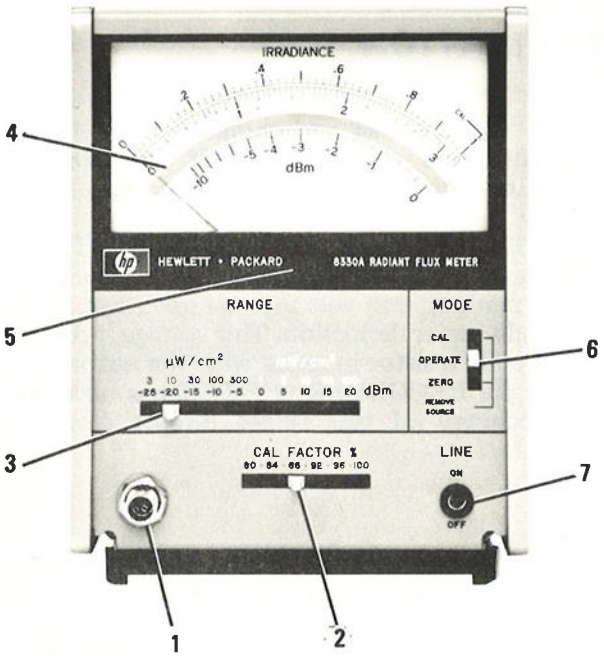
3-12. SYSTEM MEASUREMENT UNCERTAINTY

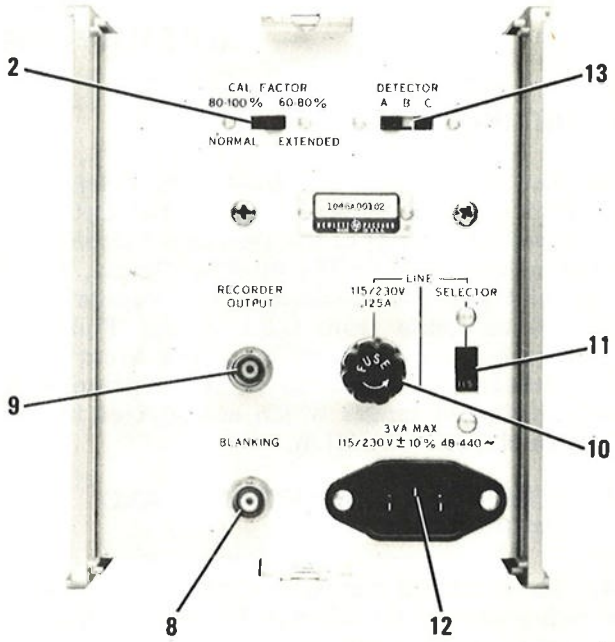
3-13. Accuracy in optical measurements made with the Model 8330A Radiant Flux Meter and Model 8334A Detector depends on the combined uncertainties of the instrument, probe, and other factors external to the measuring system.

3-14. DETECTOR UNCERTAINTIES

3-15. The major sources of error in using thermopile detectors are sensitivity changes with time, temperature, or damage; initial calibration errors in the probe; rapid ambient light and temperature variations; and uncertainty of spectral response.

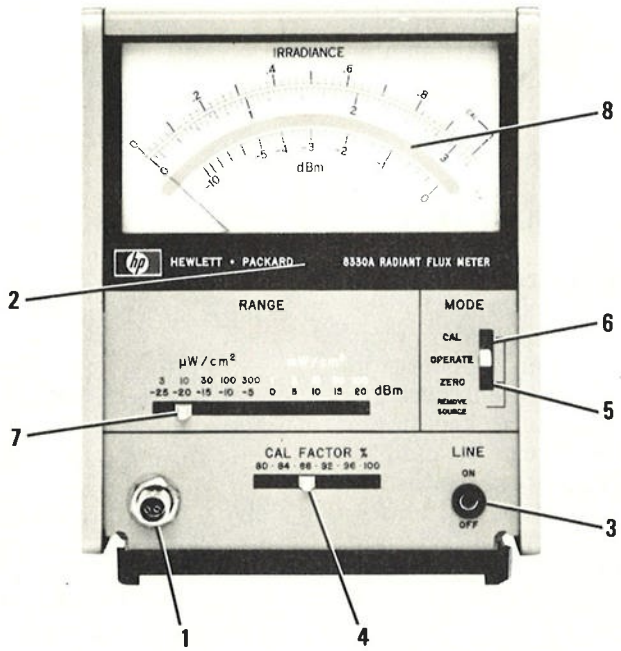
3-16. The sensitivity of the probe is subject to change due to variations in temperature, overloads, and aging. A change in probe sensitivity without a corresponding change in instrument gain will result in an erroneous reading. The Model 8330A com-





1. Detector Input Connector.
2. CAL FACTOR %. Amplifier gain compensation selector. Set to correspond to the calibration factor printed on the optical probe's body. The rear panel switch allows the range to be extended.
3. RANGE. Model 8330A range selector. Selects ranges from 3 $\mu W/cm^2$ to 100 mW/cm^2 (–25 dBm to +20 dBm).
4. Meter. Indicates input flux.
5. Mechanical Meter Zero Adjustment. Set meter suspension so the meter indicates zero. To adjust zero:
   a. Turn the Model 8330A OFF
   b. Turn the adjustment screw clockwise until the indicator falls below zero and comes back up to zero again.
   c. Turn the adjustment very slightly counterclockwise to free the mechanism from the adjusting peg.
6. MODE. Manual adjustment for the three operating modes.
   a. CAL. Automatically calibrates the Model 8330A on the 3 mW/cm^2 range.
   b. OPERATE. Normal operating mode to measure.
   c. ZERO. Automatically zeros the Model 8330A on the range in use.
7. ON/OFF. Instrument power ON/OFF switch. Connects ac line voltage.
8. BLANKING. Disables appropriate optical source and prevents it from providing radiant power to the optical mount by providing a ground connection at its output in the CAL and ZERO modes.
9. RECORDER OUTPUT. Voltage from meter circuit to be used for recorder input. Output impedance is 1000 ohms.
10. Line Fuse. Use .125 amp fuse for 115 or 230 Vac line voltage.
11. Line Voltage Slide Switch. Set to line voltage available; 115 or 230 volts ac, 50–400 Hz.
12. LINE INPUT. Use power cord provided, HP Part Number 8120-1348. Line power limits are 105–128 and 210–256 volts ac, 50–400 Hz. Check position of line voltage slide switch before connecting power.
13. Detector Switch. Permits Model 8330A to be used with different types of probes by changing instrument calibration.

Figure 3-1. Controls, Connectors, and Indicators



1. Connect the Detector cable to the Detector input jack on the front of the Model 8330A.
2. Adjust meter mechanical zero.
3. Turn the Model 8330A power switch ON.
4. Set the CAL FACTOR % switch to correspond to the Cal. Factor printed on the probe.
5. Move the MODE switch to the ZERO position and hold for several seconds. The Model 8330A is automatically zeroed.
6. Move the MODE switch to the CAL position and hold for several seconds. The Model 8330A meter pointer should move to the CAL point. The Model 8330A is now calibrated to the Model 8334A Radiant Flux Detector.
7. Set the RANGE switch to the desired position.
8. Allow some radiation to fall on the Detector. The irradiance level will be indicated on the meter in watts/cm^2.

Figure 3-2. Turn-on Procedure

pensates for probe sensitivity variations with a gain compensating feedback loop controlled by an internal precision calibrator. This results in a constant "match" of instrument and probe sensitivities. If the sensitivity change of the probe is excessive, the Model 8330A will not calibrate properly, giving an obvious indication on the front panel meter.

3-17. The initial optical calibration of the probe is traceable to NBS to the extent allowed by the Bureau's facility. The response of each probe is measured using both a calibrated lamp and a precision audio signal. The ratio of these two responses is proportional to the calibration factor of the probe. During normal use, the probe is matched to the Model 8330A by using an internal precision audio calibrator, and the CAL. FACTOR % switch on the Model 8330A is adjusted to agree with that printed on the probe. The system is then calibrated for accurate optical measurements. Future re-calibration is possible by use of a single switch located on the Model 8330A's front panel.

3-18. Hewlett-Packard optical probes are designed to be relatively immune to ambient temperature changes. However, rapidly changing conditions can cause an effect which must be taken into account for accurate measurements. The automatic "Auto-Zero" feature on the Model 8330A makes frequent re-zeroing simple by a single front panel switch. The operator never has to watch the instrument during this operation as the zero-reference is preset at the factory.

3-19. INSTRUMENT UNCERTAINTIES

3-20. The error caused by the instrument's inability to measure the exact dc output of the probe is called instrumentation uncertainty. Instrumentation uncertainty of the Model 8330A is ±1% of full-scale, 0° C to +55° C.

3-21. MEASUREMENT UNCERTAINTIES EXTERNAL TO INSTRUMENTATION

3-22. There are many sources of errors in optical power measurements which are external to the actual measuring device. For example, major errors can occur due to a reduction in signal transmission when filters or lenses are used, or when there are rapidly fluctuating ambient conditions. The Model 8330A's CAL. FACTOR % switch can be used to raise the gain of the system to compensate for the known transmittance of various filters and lenses. In addition, the convenience of Auto-Zero and Auto-Calibrate reduces the severity of the problems associated with changing environmental conditions.

3-23. OPERATOR PERFORMANCE CHECK

3-24. The following procedure is an operator check to verify operation of the HP Model 8330A Radiant Flux Meter before making optical measurements. The only test equipment required is the Range Calibrator. Refer to the Model 8334A operating note for procedures to check the Detector.

a. Connect the Range Calibrator to the front of the Model 8330A.

b. Set the instrument controls as follows:

Calibrator
RANGE . . . . . 3 mW/cm^2
Model 8330A
RANGE . . . . . 3 mW/cm^2
CAL FACTOR %. . . 100%, 80—100% range
MODE . . . . . CAL
Detector Type . . . . . A

c. Switch the Range Calibrator to the test position.

d. Switch the Model 8330A MODE switch to the CAL position.

e. The pointer on the Model 8330A meter should move to the CAL mark. Return the MODE switch to the OPERATE position. The Model 8330A is now calibrated to the Range Calibrator's output.

f. Move the Model 8330A RANGE switch to 100 mW/cm^2. Move the Range Calibrator RANGE switch to the 100 mW/cm^2 position. The Model 8330A meter should be at the full-scale CAL point.

g. Reduce the RANGE switch on the Range Calibrator to 30 mW/cm^2 and then turn the Model 8330A RANGE to 30 mW/cm^2. The Model 8330A meter should be at the full-scale CAL point.

h. Reduce the RANGE of the Range Calibrator and Model 8330A one step. The Model 8330A meter should always read at the full-scale CAL point; this includes those scales which indicate 0 to 3.

i. Repeat step h until the lowest range (3 μW/cm^2) is reached.

CAUTION

To insure that the meter reading is accurate, it may be necessary to zero the instrument before each step on the lower ranges. This re-zeroing is necessary due to the possibility of thermal shock transients during handling. The zeroing procedure should start at approximately 100 μW/cm^2. To zero, turn the Range Calibrator RANGE switch to the OFF position and the Model 8330A MODE switch to ZERO for about 4 seconds. This zeros the instrument. Return the Model 8330A MODE switch and return the Range Calibrator to the test position. The instrument should read on the CAL point on the meter face.

j. If at any time the Model 8330A does not go to full-scale during the check, refer to Section VI, Maintenance, for corrective measures.

SECTION IV
PERFORMANCE TEST AND ADJUSTMENT PROCEDURES

4-1. INTRODUCTION

4-2. This section contains the procedures for verifying performance of the Model 8330A Radiant Flux Meter and the adjustments necessary to calibrate the instrument. Procedures are arranged in numerical order. This order should be followed for best results. Data taken during the initial test and adjustment procedures can be recorded on the test cards that are located in this section. Comparison of the initial data with data taken during periodic calibration assists in preventive maintenance and troubleshooting.

4-3. TEST EQUIPMENT

4-4. Equipment listed in Tables 4-1 and 4-2 includes all test equipment and accessories necessary to test the Model 8330A Radiant Flux Meter according to the procedures in this manual.

4-5. PERFORMANCE TEST CARD

4-6. Each data point in the performance test is repeated in the performance test card. The card is perforated and can be removed for filing and referred to when maintenance is required.

4-7. CHECK AND ADJUSTMENT TEST CARD

4-8. Each data point in the adjustment and check procedures is repeated in the check and adjustment test card. The card is perforated so it can be removed for filing and referred to during preventive maintenance or troubleshooting.

4-9. POZIDRIV SCREWDRIVERS

4-10. Many screws in the instrument appear to be Phillips, but are not. Table 4-2 gives a number and a name of the Pozidriv screwdriver designed to fit the screws. Pozidriv screwdrivers must be used to avoid damage to the screw slots.

Table 4-1. Recommended Test Equipment

Instrument Type	Critical Specifications	Recommended HP Model
True RMS AC Meter	Accuracy: ±0.08% of reading +0.02% of range, 90 days, (25°C ±5°C) Input Impedance: 2 megohm, shunted by 90 pF, balanced and floating Resolution: Five digits	3450A or 3480/3484
DC Digital Voltmeter	Accuracy: ±.05% of reading Input Impedance: 10 megohm	3450A 3440/3443A
AC Voltmeter	Accuracy: at least ±2% at 120 Hz Range: .001 to 300 volts	400D/E/F
Range Calibrator (for Model 8330A Meter)	Range: 3 $\mu W/cm^2$ to 100 mW/cm^2 Output Impedance: 474 ohms ±0.1%	11594A
Oscilloscope	Sensitivity: 5 mV/div Input Impedance: 1 megohm General purpose time base with internal trigger	180A or 180AR 1820A
Detector	Operating Resistance: 474 ohms	8334A

Table 4-2. Recommended Accessories

Item	Description	Recommended HP Model
Adapter	BNC male to binding post	10110A
Adapter	BNC female to binding post	10111A
Cable	Four feet, 50-ohm coaxial cable terminated with BNC male connectors	10503A
Test Leads	Five feet, dual banana plug to alligator clips	11002A
Oscilloscope Probe	10:1 Divider, 10 megohm resistance, 10 pF capacitor	10004A
Screwdriver	Pozidriv No. 1 (small)	8710-0899

4-11. PERFORMANCE TEST

4-12. The Model 8330A Radiant Flux Meter and the Range Calibrator should be connected and power applied for at least one-half hour before any performance test or adjustments are made.

The Range Calibrator is a precise voltage source and divider capable of providing nanovolt signals with low drift and noise.

4-13. The Model 8330A covers should be left on except for the right side cover that provides access to the A1 Amplifier board.

4-14. Range-to-Range Accuracy

a. Connect the Range Calibrator to the input jack on the front of the instrument and connect a Model 3440/3443 DVM to the RECORDER OUTPUT on the rear panel of the Model 8330A (see Figure 4-1).

b. Set the instrument as follows:

Range Calibrator
RANGE . . . . . 3 mW/cm^2
MODE . . . . . .OFF

Model 8330A
CAL FACTOR % . 100%, 80 to 100% Range
MODE . . . . . OPERATE
RANGE . . . . . 3 mW/cm^2
DETECTOR TYPE . . . . . A

Model 3440/3443
RANGE . . . . . AUTO or 10V

c. Hold the Model 8330A MODE switch in the ZERO position for at least four seconds.

d. Release the MODE switch and switch the Range Calibrator to the test position. Hold the Model 8330A MODE switch in the CAL position for about two seconds then return the switch to the OPERATE position. The DVM should read 1.000 volts ±.010 volt.

+0.990V_____+1.010V

e. The Model 8330A Radiant Flux Meter is now calibrated to the Range Calibrator.

f. Move the Model 8330A and Range Calibrator RANGE switches to the 100 mW/cm^2 position. The DVM should read 1.000V ±10 mV.

g. Step down through the complete range on the Model 8330A making sure that the Model

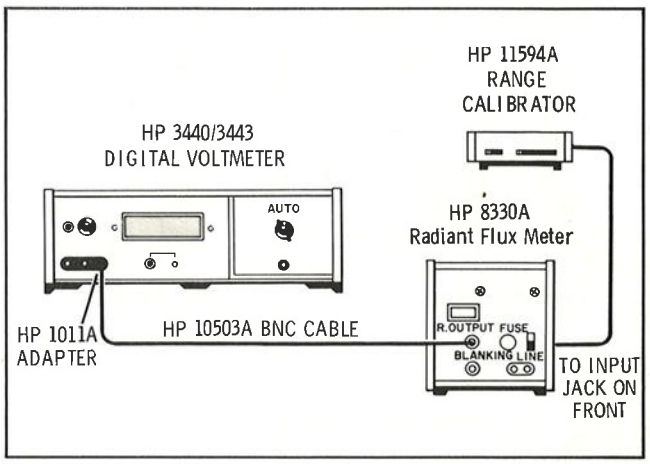


Figure 4-1. Range-to-Range Accuracy Test

8330A and Range Calibrator RANGE switches match. The DVM reading should always be 1.000V ±10 mV.

+0.990V_____+1.010V

Note

It may be necessary to zero the Model 8330A on the lower ranges before checking the range accuracy. The Range Calibrator must be in the OFF position. Zeroing is usually required on the 100 $\mu W/cm^2$ range and lower. To zero the instrument repeat steps a through c.

h. On the 3 $\mu W/cm^2$ and 10 $\mu W/cm^2$ RANGES, the limits on the DVM are extended to include any noise excursions. The DVM reading for the 10 $\mu W/cm^2$ RANGE is 1.000V ±0.015V. On the 3 $\mu W/cm^2$ RANGE the DVM should read 1.000V ±0.030V.

10 $\mu W/cm^2$ RANGE +0.985V_____+1.015V
3 $\mu W/cm^2$ RANGE +0.970V_____+1.030V

i. If the range-to-range accuracy does not check out correctly refer to Service Sheet 1.

4-15. Zero Carry Over

a. Connect the Range Calibrator to the Radiant Detector input jack on the front of the Model 8330A. Connect a Model 3440/3443 DVM to the RECORDER OUTPUT jack on the rear panel of the Model 8330A. See Figure 4-1 for the test set-up.

b. Set the instrument controls as follows:

Range Calibrator
RANGE . . . . . 3 $\mu W/cm^2$
MODE . . . . . OFF

Model 8330A
CAL FACTOR % . 100%, 80 to 100% Range
MODE . . . . . OPERATE
RANGE . . . . . 3 $\mu W/cm^2$
DETECTOR TYPE . . . . . A

Model 3440/3443
RANGE . . . . . AUTO or 100 mV

c. Move the Model 8330A MODE switch to the ZERO position and hold for at least four seconds. Release the MODE switch. The DVM should read 0V ±30 mV.

−30 mV_____+30 mV

d. Move the Model 8330A RANGE switch to the 10 $\mu W/cm^2$ position. The DVM should read 0V ±15 mV.

−15 mV_____+15 mV

e. Increase the Model 8330A RANGE switch one (1) step. The DVM should read 0V ±5 mV.

−5 mV_____+5 mV

f. Repeat step e, going through the rest of the ranges. The DVM should read 0V ±3 mV (refer to Table 4-3 for Range and DVM readings).

Table 4-3. Zero Carry Over Limits

Range	DVM Readings		
3 $\mu W/cm^2$	−30 mV	_____	+ 30 mV
10 $\mu W/cm^2$	−15 mV	_____	+15 mV
30 $\mu W/cm^2$	−5 mV	_____	+5 mV
100 $\mu W/cm^2$	−3 mV	_____	+3 mV
300 $\mu W/cm^2$	−3 mV	_____	+3 mV
1 mW/cm^2	−3 mV	_____	+3 mV
3 mW/cm^2	−3 mV	_____	+3 mV
10 mW/cm^2	−3 mV	_____	+3 mV
30 mW/cm^2	−3 mV	_____	+3 mV
100 mW/cm^2	−3 mV	_____	+3 mV

4-16. Calibration Oscillator Accuracy

a. Connect the Range Calibrator to the Detector input jack on the front panel of the Model 8330A Meter.

b. Connect a Model 3450A Multi-Function Digital Voltmeter (Option 01) between pins 11 and 12 of terminal XA1 (see Figure 6-7 for location of XA1). Connect the Model 3450A guard to chassis ground on the Model 8330A. See Figure 4-2 for the test set-up.

c. Set the instrument controls as follows:

Range Calibrator
RANGE . . . . . Any
MODE . . . . . OFF

Model 8330A
CAL FACTOR % . 100%, 80 to 100% Range
MODE . . . . . OPERATE
RANGE . . . . . 3 mW/cm^2
DETECTOR TYPE . . . . . A

Model 3450A
RANGE . . . . . AUTO
FUNCTION . . . . . AC
CONTROL . . . . . LOCAL
TRIGGER . . . . . INT

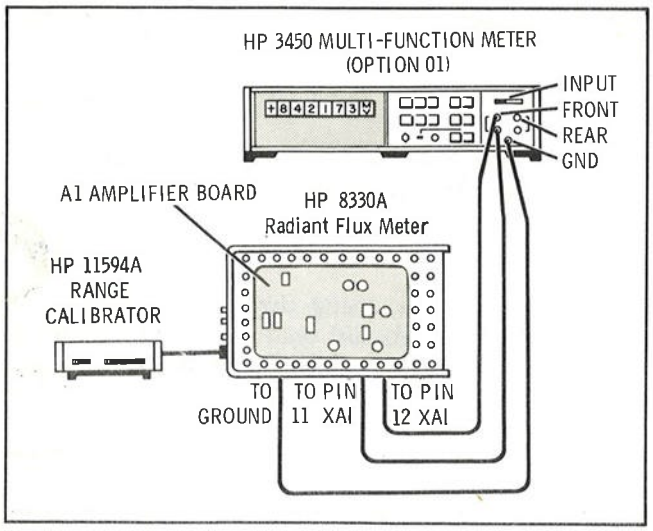


Figure 4-2. Calibration Oscillator Amplitude Accuracy Test

d. Move the Model 8330A MODE switch to the CAL position and hold the switch in this position. The Model 3450A DVM should read 0.4329 Vrms ±.0004.

0.4325 Vrms_____0.4333 Vrms

Note

When using a true rms voltmeter such as the Model 3450A Option 01, the distortion of the waveform does not affect the accuracy of the measurement. If an average responding AC VTVM is substituted, harmonic distortion of the signal must be less than one percent (–40 dB). Harmonic distortion can be measured with a HP Model 302A or Model 310A Wave Analyzer, Model 8552B/8553B Spectrum analyzer, or a HP Model 331 Distortion Analyzer.

e. Remove the Model 3450A from the test set-up and connect a 180 Oscilloscope to A1TP13. See Figure 4-3 for the test set-up.

f. Set the instrument controls as follows:

Range Calibrator
RANGE . . . . . 3 mW/cm²
MODE . . . . . OFF

Model 8330A
CAL FACTOR % . 100%, 80 to 100% Range
MODE . . . . . OPERATE
RANGE . . . . . 3 mW/cm²
DETECTOR TYPE . . . . . A

180 Oscilloscope
TIME/DIV . . . . . 20 μsec
SYNC . . . . . INT
SWEEP MODE . . . . . AUTO
VOLTS/DIV 05

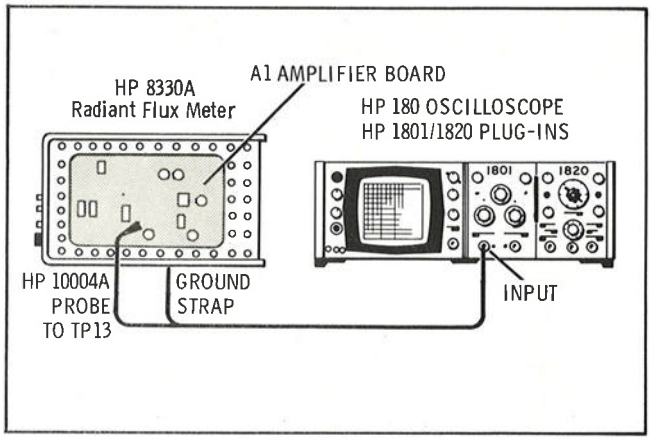


Figure 4-3. Calibration Oscillator Frequency Test

g. The frequency of the calibration oscillator must be 10 kHz ±3 kHz. The oscilloscope will display about two cycles with the above settings.

7 kHz_____13 kHz

4-17. Calibration Factor Accuracy

a. Connect the Range Calibrator to the Detector input jack on the front of the Model 8330A. Connect a Model 3440/3443 DVM to the RECORDER OUTPUT as shown in Figure 4-4.

b. Set the instrument controls as follows:

Range Calibrator
RANGE . . . . . 3 mW/cm²
MODE . . . . . Test

Model 8330A
CAL FACTOR % . 100%, 80 to 100% Range
MODE . . . . . OPERATE
RANGE . . . . . 3 mW/cm²
DETECTOR TYPE . . . . . A

Model 3440/3443
RANGE . . . . . AUTO or 10V

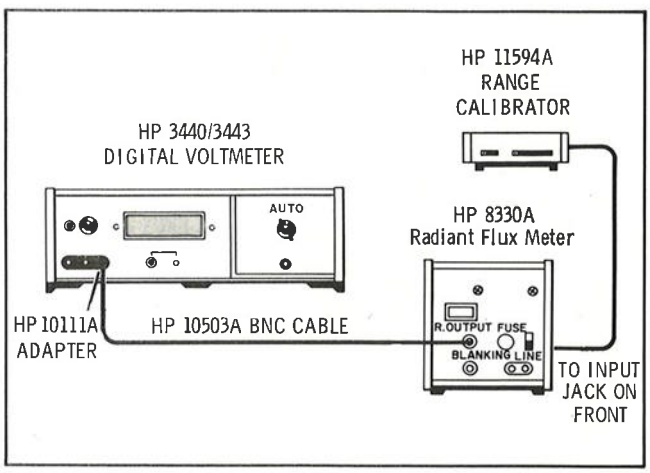


Figure 4-4. Calibration Factor Accuracy Test

Table 4-4. Calibration Factor Limits

CAL FACTOR % Setting	DVM Reading Volts DC			
100	1.000V ± 10 mV	+0.990	_____	+1.010
96	1.044V ± 10 mV	+1.034	_____	+1.054
92	1.089V ± 10 mV	+1.079	_____	+1.099
88	1.136V ± 10 mV	+1.126	_____	+1.146
84	1.190V ± 10 mV	+1.180	_____	+1.200
80	1.250V ± 10 mV	+1.240	_____	+1.260

c. Hold the Model 8330A MODE switch in the CAL position for three seconds and then release.

d. The DVM should read 1.000 volts ±10 mV in the 100 position of the CAL FACTOR % switch.

+0.990V_____+1.010V

e. Check the calibration factor accuracy in every alternate position of the CAL FACTOR % switch (98, 96, 94, etc.). Refer to Table 4-4 for the correct DVM indication at each position. When making this measurement the Model 8330A meter will peg up scale, a normal condition for this measurement.

Note

The 4% steps of CAL FACTOR % numbers are marked on the front panel. The 2% steps of the CAL FACTOR % numbers are designated with a dot (·) between the even numbers. When making this measurement make sure the CAL FACTOR % switch is in the correct position.

4-18. ADJUSTMENTS AND CHECK PROCEDURES

4-19. Before performing any adjustment or check procedures, the Model 8330A Radiant Flux Meter and the Range Calibrator should be connected, power applied, and the instrument allowed to warm up for at least one-half hour.

4-20. Power Supply Check

a. Connect a Model 3440/3443 DVM and a Model 400D/E/F AC Voltmeter in parallel to A1TP8 (see Service Sheet 1, Figure 1-A for test point locations) as shown in Figure 4-5.

b. Set the instrument controls as follows:

Range Calibrator
RANGE . . . . . Any
MODE . . . . . OFF

Model 8330A
CAL FACTOR % . 100%, 80 to 100% Range
MODE . . . . . OPERATE
RANGE . . . . . Any
DETECTOR TYPE . . . . . A

Model 3440/3443
RANGE . . . . . AUTO or 100V

Model 400D/E/F
RANGE . . . . . 10 mV

c. The DVM should indicate +16.5V ±1V. Ripple voltage indicated by the HP Model 400 should be less than 5 mVrms.

DVM + 15.5V_____+17.5V
HP Model 400_____<5 mVrms

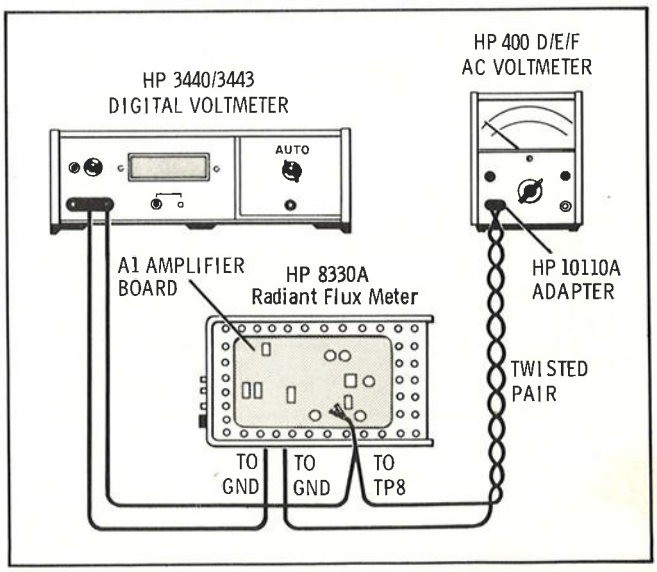


Figure 4-5. Power Supply Check

4-21. Multivibrator Frequency Check

a. Connect the Model 180A Oscilloscope between A1TP10 and ground (see Service Sheet 1, Figure 1-A for test point locations) as shown in Figure 4-6.

b. Set the instrument controls as follows:

Note

The Model 180A settings take into consideration that a 10:1 voltage divider probe is being used in this measurement.

Range Calibrator
RANGE . . . . . Any
MODE . . . . . OFF

Model 8330A
CAL FACTOR % . 100%, 80 to 100% Range
MODE . . . . . OPERATE
RANGE . . . . . Any
DETECTOR TYPE . . . . . A

Model 180A
TIME/DIV 1msec
SYNC . . . . . INT
SWEEP MODE . . . . . AUTO
VOLTS/DIV 5

c. Measure the frequency of the multivibrator. The frequency should be 107 Hz ±2 Hz. The period of 107 Hz equals 9.35 milliseconds. With the above scope settings, 107 Hz will equal approximately 9.3 cm on the CRT. The period of the multivibrator waveforms should fall within 9.1 and 9.6 cm on the oscilloscope CRT.

CRT 9.1 div_____9.6 div

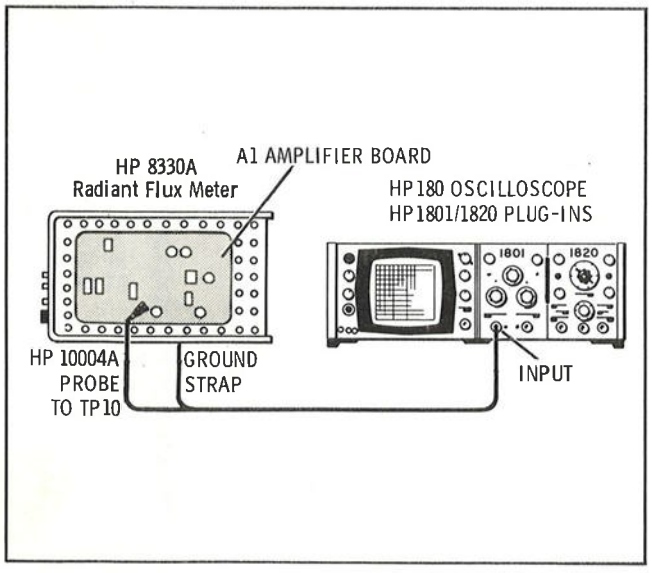


Figure 4-6. Multivibrator Frequency Check

4-22. Calibration Oscillator Amplitude Adjustment

a. Connect a Range Calibrator to the Detector input jack on the front panel of the Model 8330A.

b. Connect a Model 3450A Multi-Function Digital Voltmeter (Option 01) between pins 11 and 12 of terminal XA1 (see Figure 6-7 for location of XA1). Connect the Model 3450A guard to chassis ground on the Model 8330A. See Figure 4-7 for the test set-up.

c. Set the instrument controls as follows:

Range Calibrator
RANGE . . . . . Any
MODE . . . . . OFF

Model 8330A
CAL FACTOR % . 100%, 80 to 100% Range
MODE . . . . . OPERATE
RANGE . . . . . 3 mW/cm^2
DETECTOR TYPE . . . . . A

Model 3450A (Option 01)
RANGE . . . . . AUTO
FUNCTION . . . . . AC
CONTROL . . . . . LOCAL
TRIGGER . . . . . INT

d. Move the Model 8330A MODE switch to the CAL position and hold the switch in this position. Adjust A1R68 (see Service Sheet 1, Figure 1-A for location of A1R68) for a Model 3450A reading of 0.4329 Vrms ±0.0004 Vrms.

0.4325 Vrms_____0.4333 Vrms

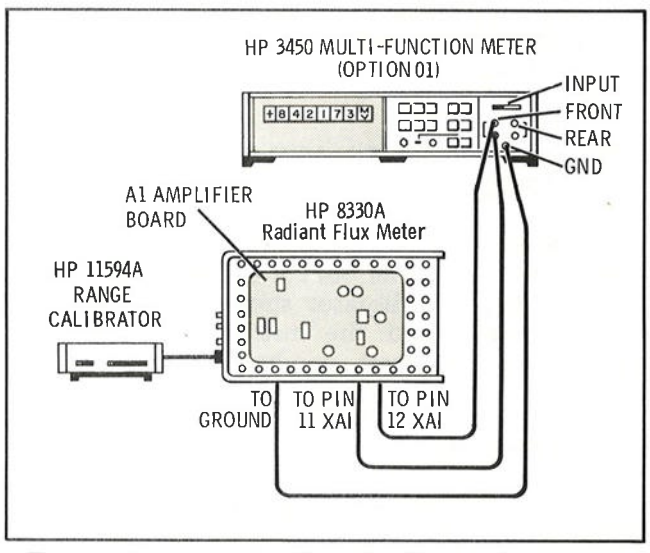


Figure 4-7. Calibration Oscillator Amplitude Adjustment

Note

When using a true rms voltmeter such as the Model 3450A (Option 01), distortion of the waveform does not affect the accuracy of the measurement. If an average responding AC VTVM is substituted, harmonic distortion of the signal must be less than 1% (–40 dB). Harmonic distortion can be measured with a HP Model 302A or Model 310A Wave Analyzer, Model 8552B/8553B Spectrum Analyzer, or a HP Model 331 Distortion Analyzer.

4-23. Zero Cal Circuit Adjustment

a. Connect the Range Calibrator to the Detector input jack. Connect a Model 3440/3443 DVM to the RECORDER OUTPUT as shown in Figure 4-8.

b. Set the instrument controls as follows:

Range Calibrator
RANGE . . . . . 3 mW/cm²
MODE . . . . . Test

Model 8330A
CAL FACTOR % . 100%, 80 to 100% Range
MODE . . . . . OPERATE
RANGE . . . . . 3 mW/cm²
DETECTOR TYPE . . . . . A

Model 3440/3443
RANGE . . . . . AUTO or 10V

c. Place the Model 8330A MODE switch in the CAL position and adjust A1R99 (See Service Sheet 1, Figure 1-A for all adjustment locations) for a DVM reading of 1.000V ±1 mV.

DVM +0.999V_____1.001V

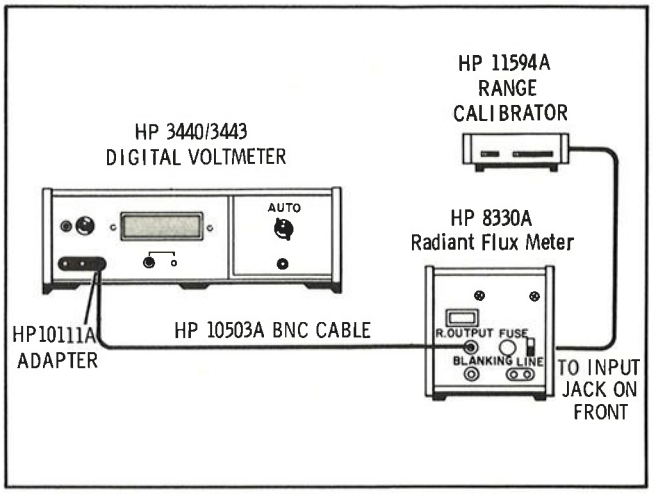


Figure 4-8. Zero/Cal Circuit Adjustment

d. Move the MODE switch to the CAL position and hold it there. Adjust A1R32 for a full-scale reading (±1/4 divisions) on the Model 8330A front panel meter.

Meter –1/4 div_____+1/4 div

e. Turn the Range Calibrator to the OFF position. Switch the Model 8330A range to 3 μW/cm² and move the MODE switch to the ZERO position and hold it there. Adjust A1R96 for a DVM reading of 0.000V ±.005V.

DVM –.005V_____+.005V

f. This completes the adjustment procedures. Turn to Performance Test, Paragraph 4-11, and verify that the instrument is operating within specifications.

4-24. The Performance Test and Check and Adjustment Test cards are given in Tables 4-5 and 4-6.

Notes

INSTRUMENT SERIAL NO. _____

DATE _____

TABLE 4-5. PERFORMANCE TEST CARD

Data in this table corresponds to procedures in Paragraphs 4-11 through 4-17.

Table 4-5. Performance Test Card

Para. No.	Test Description		Meas. Units	Minimum	Actual	Maximum
4-14	Range-to-Range Accuracy					
	Range Calibrator	8330A Range				
h	3 $\mu W/cm^2$	3 $\mu W/cm^2$	Vdc	+0.970	_____	+1.030
h	10 $\mu W/cm^2$	10 $\mu W/cm^2$	Vdc	+0.985	_____	+1.015
g	30 $\mu W/cm^2$	30 $\mu W/cm^2$	Vdc	+0.990	_____	+1.010
g	100 $\mu W/cm^2$	100 $\mu W/cm^2$	Vdc	+0.990	_____	+1.010
g	300 $\mu W/cm^2$	300 $\mu W/cm^2$	Vdc	+0.990	_____	+1.010
g	1 mW/cm^2	1 mW/cm^2	Vdc	+0.990	_____	+1.010
g	3 mW/cm^2	3 mW/cm^2	Vdc	+0.990	_____	+1.010
g	10 mW/cm^2	10 mW/cm^2	Vdc	+0.990	_____	+1.010
g	30 mW/cm^2	30 mW/cm^2	Vdc	+0.990	_____	+1.010
f	100 mW/cm^2	100 mW/cm^2	Vdc	+0.990	_____	+1.010
4-15	Zero Carry-Over					
	Range ($\mu W/mW$)	DVM Reading (mVdc)				
c	3 $\mu W/cm^2$	0 ±30 mV	mVdc	-30	_____	+30
d	10 $\mu W/cm^2$	0 ±15 mV	mVdc	-15	_____	+15
e	30 $\mu W/cm^2$	0 ±5 mV	mVdc	-5	_____	+5
f	100 $\mu W/cm^2$	0 ±3 mV	mVdc	-3	_____	+3
f	300 $\mu W/cm^2$	0 ±3 mV	mVdc	-3	_____	+3
f	1 mW/cm^2	0 ±3 mV	mVdc	-3	_____	+3
f	3 mW/cm^2	0 ±3 mV	mVdc	-3	_____	+3
f	10 mW/cm^2	0 ±3 mV	mVdc	-3	_____	+3
f	30 mW/cm^2	0 ±3 mV	mVdc	-3	_____	+3
f	100 mW/cm^2	0 ±3 mV	mVdc	-3	_____	+3
4-16	Calibration Oscillator Accuracy					
d	3450A Reading					
	0.4329 Vrms ±0.0004 Vrms (.1%)		Vrms	0.4325	_____	0.4333
g	Oscilloscope					
	Frequency – 10 kHz ±3 kHz		kHz	7	_____	13
4-17	Calibration Factor Accuracy					
	CAL FACTOR %	DVM Reading (Vdc)				
d	100	1.000V ±10 mV	Vdc	+0.990	_____	+1.010
e	96	1.044V ±10 mV	Vdc	+1.034	_____	+1.054
e	92	1.089V ±10 mV	Vdc	+1.079	_____	+1.099
e	98	1.136V ±10 mV	Vdc	+1.126	_____	+1.146
e	84	1.190V ±10 mV	Vdc	+1.180	_____	+1.200
e	80	1.250V ±10 mV	Vdc	+1.240	_____	+1.260

INSTRUMENT SERIAL NO. _____

DATE _____

TABLE 4-6. CHECK AND ADJUSTMENT TEST CARD

Data in this table corresponds to procedures in paragraphs 4-18 through 4-23.

Table 4-6. Check and Adjustment Test Card

Para. No.	Test Description	Measurement Units	Minimum	Actual	Maximum
4-20	Power Supply Check				
c	+16 volt supply +16.5V ±1V	Vdc	+15.5	_____	+17.5
d	−16 volt supply −16V ±1V	Vdc	−15.0	_____	−17.0
	Ripple				
c	+16 volt supply	mVrms		_____	<5
d	−16 volt supply	mVrms		_____	<5
4-21	Multivibrator Frequency Check				
c	Frequency 107 Hz ±2 Hz CRT divisions 9.3 cm	cm	9.1	_____	9.6
4-22	Calibration Oscillator Amplitude Adjustment				
d	Meter Indication 0.4329 Vrms ±0.0004 Vrms (.1%)	Vrms	0.4325	_____	0.4333
4-23	Zero/Cal Circuit Adjustment				
	Mode DVM Reading				
c	CAL 1.000V ±.001V	Vdc	+.999	_____	+1.001
d	CAL 8330A Meter Reading	divisions	−1/4	_____	+1/4
e	ZERO 0.000V ±.005V	Vdc	−.005	_____	+.005

SECTION V
REPLACEABLE PARTS

5-1. INTRODUCTION

5-2. This section contains information for ordering replaceable parts. Table 5-1 gives the meanings of the abbreviations and reference designations used in the table of replaceable parts.

5-3. Table 5-2 is the table of replaceable parts and is organized as follows:

a. Electrical assemblies and their component parts in alpha-numerical order by reference designation.

b. Chassis parts in alpha-numerical order by reference designation.

c. Miscellaneous parts.

d. Illustrated parts breakdowns, if appropriate.

5-4. The information given for each part consists of:

a. The Hewlett-Packard part number.

b. Total quantity (QTY) in the instrument. Total quantity for each part is given only once — at the first appearance of the part number.

c. Description of the part.

d. Typical manufacturer of the part, in a five-digit code.

e. The manufacturer's number for the part.

5-5. Table 5-3 contains the names and addresses that correspond to the manufacturer's code numbers.

5-6. ORDERING INFORMATION

5-7. To order a part listed in the replaceable parts table, quote the Hewlett-Packard part number, indicate the quantity required, and address the order to the nearest Hewlett-Packard office.

5-8. To order a part that is not listed in the replaceable parts table, include the instrument model number, instrument serial number, the description and function of the part, and the number of parts required. Address the order to the nearest Hewlett-Packard office.

Table 5-1. Reference Designators and Abbreviations

REFERENCE DESIGNATORS

A	= assembly	F	= fuse	P	= plug	V	= vacuum tube, neon bulb, photocell, etc.
B	= motor	FL	= Filter	Q	= transistor		
BT	= battery	J	= jack	R	= resistor		
C	= capacitor	K	= relay	RT	= thermistor	VR	= voltage regulator
CP	= coupler	L	= inductor	S	= switch		
CR	= diode	LS	= loud speaker	T	= transformer	W	= cable
DL	= delay line	M	= meter	TB	= terminal board	X	= socket
DS	= device signaling (lamp)	MK	= microphone	TP	= test point	Y	= crystal
E	= misc electronic part	MP	= mechanical part	U	= integrated circuit	Z	= tuned cavity, network

ABBREVIATIONS

A	= amperes	H	= henries	N/O	= normally open	RMO	= rack mount only
AFC	= automatic frequency control	HDW	= hardware	NOM	= nominal	RMS	= root-mean square
		HEX	= hexagonal	NPO	= negative positive zero (zero temperature coefficient)	RWV	= reverse working voltage
AMPL	= amplifier	HG	= mercury				
		HR	= hour(s)			S-B	= slow-blow
BFO	= beat frequency oscillator	Hz	= Hertz			SCR	= screw
				NPN	= negative-positive-negative	SE	= selenium
BE CU	= beryllium copper	IF	= intermediate freq			SECT	= section(s)
BH	= binder head	IMPG	= impregnated	NRFR	= not recommended for field replacement	SEMICON	= semiconductor
BP	= bandpass	INCD	= incandescent			SI	= silicon
BRS	= brass	INCL	= include(s)			SIL	= silver
BWO	= backward wave oscillator	INS	= insulation(ed)	NSR	= not separately replaceable	SL	= slide
		INT	= internal			SPG	= spring
						SPL	= special
CCW	= counterclockwise	K	= kilo = 1000	OBD	= order by description	SST	= Stainless steel
CER	= ceramic					SR	= split ring
CMO	= cabinet mount only			OH	= oval head	STL	= steel
COEF	= coefficient	LH	= left hand	OX	= oxide		
COM	= common	LIN	= linear taper				
COMP	= composition	LK WASH	= lock washer	P	= peak	TA	= tantalum
COMPL	= complete	LOG	= logarithmic taper	PC	= printed circuit	TD	= time delay
CONN	= connector	LPF	= low pass filter	PF	= picofarads = 10^{-12} farads	TGL	= toggle
CP	= cadmium plate					THD	= thread
CRT	= cathode-ray tube			PH BRZ	= phosphor bronze	TI	= titanium
CW	= clockwise	M	= milli = 10^{-3}	PHL	= Phillips	TOL	= tolerance
		MEG	= meg = 10^{6}	PIV	= peak inverse voltage	TRIM	= trimmer
DEPC	= deposited carbon	MET FLM	= metal film			TWT	= traveling wave tube
DR	= drive	MET OX	= metallic oxide	PNP	= positive-negative-positive		
		MFR	= manufacturer				
ELECT	= electrolytic	MHz	= mega Hertz	P/O	= part of	μ	= micro = 10^{-6}
ENCAP	= encapsulated	MINAT	= miniature	POLY	= polystrene		
EXT	= external	MOM	= momentary	PORC	= porcelain		
		MOS	= metalized substrate	POS	= position(s)	VAR	= variable
F	= farads			POT	= potentiometer	VDCW	= dc working volts
FH	= flat head	MTG	= mounting	PP	= peak-to-peak		
FIL H	= Fillister head	MY	= "mylar"	PT	= point		
FXD	= fixed			PWV	= peak working voltage	W/	= with
		N	= nano (10^{-9})			W	= watts
G	= giga (10^{9})	N/C	= normally closed	RECT	= rectifier	WIV	= working inverse voltage
GE	= germanium	NE	= neon	RF	= radio frequency		
GL	= glass	NI PL	= nickel plate	RH	= round head or right hand	WW	= wirewound
GRD	= ground(ed)					W/O	= without

Table 5-2. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1	08330-60001	1	BOARD ASSY:MAIN	28480	08330-60001
A1C1	0180-0106	3	C:FXD ELECT 60 UF 20% 6VDCW	28480	0180-0106
A1C2	0160-C166	1	C:FXD MY 0.0068 UF 10% 200VDCW	56289	192P68392-PTS
A1C3	0170-0040	3	C:FXD MY 0.047 UF 10% 200VDCW	56289	192P47392-PTS
A1C4	0180-0106		C:FXD ELECT 60 UF 20% 6VDCW	28480	0180-0106
A1C5	0160-C162	1	C:FXD MY 0.022 UF 10% 200VDCW	56289	192P22392-PTS
A1C6	0170-0040		C:FXD MY 0.047 UF 10% 200VDCW	56289	192P47392-PTS
A1C7			NOT ASSIGNED.		
A1C10			NOT ASSIGNED		
A1C11	0180-C106		C:FXD ELECT 60 UF 20% 6VDCW	28480	0180-0106
A1C12			NOT ASSIGNED		
A1C13	0180-0291	2	C:FXD ELECT 1.0 UF 10% 35VDCW	56289	150D105X9035A2-DYS
A1C14	0180-C291		C:FXD ELECT 1.0 UF 10% 35VDCW	56289	150D105X9035A2-DYS
A1C15	0160-2917	3	C:FXD CER 0.05 UF +80-20% 100VDCW	84411	TYPE TA
A1C16			NOT ASSIGNED		
A1C17	0150-C050	2	C:FXD CER 1000 PF +80-20% 1000VDCW	56289	C067B102E102ZS26-CDH
A1C18	0160-C174	2	C:FXD CER 0.47 UF +80-20% 25VDCW	56289	5C1187S-CML
A1C19	0160-2930	1	C:FXD CER 0.01 UF +80-20% 100VDCW	91418	TA
A1C20	0160-C174		C:FXD CER 0.47 UF +80-20% 25VDCW	56289	5C1187S-CML
A1C21	0150-C050		C:FXD CER 1000 PF +80-20% 1000VDCW	56289	C067B102E102ZS26-CDH
A1C22			NOT ASSIGNED		
A1C23			NOT ASSIGNED		
A1C24	0160-2917		C:FXD CER 0.05 UF +80-20% 100VDCW	84411	TYPE TA
A1C25			NOT ASSIGNED		
A1C26	0170-0040		C:FXD MY 0.047 UF 10% 200VDCW	56289	192P47392-PTS
A1C27			NOT ASSIGNED		
A1C28			NOT ASSIGNED		
A1C29	0140-0172	3	C:FXD MICA 3000 PF 1% 100VDCW	28480	0140-0172
A1C30	0180-C141	2	C:FXD ELECT 50 UF +75-10% 50VDCW	56289	30D506G050DD2-DSM
A1C31	0180-0141		C:FXD ELECT 50 UF +75-10% 50VDCW	56289	30D506G050DD2-DSM
A1C32	0180-C197	3	C:FXD ELECT 2.2 UF 10% 20VDCW	56289	150D225X9020A2-DYS
A1C33	0180-C374	2	C:FXD ELECT 10.0 UF 10% 20VDCW	56289	150D1C6X9020B2-76
A1C34	0180-0374		C:FXD ELECT 10.0 UF 10% 20VDCW	56289	150D1C6X9020B2-76
A1C35	0160-0164	2	C:FXD MY 0.039 UF 10% 200VDCW	56289	192P39392-PTS
A1C36	0160-C164		C:FXD MY 0.039 UF 10% 200VDCW	56289	192P39392-PTS
A1C37	0180-C054	2	C:FXD ELECT 100 UF +75-10% 25VDCW	56289	30D107G025DD2-DSM
A1C38	0180-C054		C:FXD ELECT 100 UF +75-10% 25VDCW	56289	30D107G025DD2-DSM
A1C39			NOT ASSIGNED		
A1C40	0140-0172		C:FXD MICA 3000 PF 1% 100VDCW	28480	0140-0172
A1C41	0180-C228	3	C:FXD ELECT 22 UF 10% 15VDCW	56289	150D226X9015B2-DYS
A1C42	0180-1743	1	C:FXD ELECT 0.1 UF 10% 35VDCW	56289	150D104X9035A2-DYS
A1C43	0180-C228		C:FXD ELECT 22 UF 10% 15VDCW	56289	150D226X9015B2-DYS
A1C44	0160-2917		C:FXD CER 0.05 UF +80-20% 100VDCW	84411	TYPE TA
A1C45			NOT ASSIGNED		
A1C46	0180-2215	2	C:FXD ELECT 170 UF +75-10% 15VDCW	28480	0180-2215
A1C47	0180-2215		C:FXD ELECT 170 UF +75-10% 15VDCW	28480	0180-2215
A1C48	0160-3459	1	C:FXD CER 0.02 UF 20% 100VDCW	56289	C023F101H203MS22CDH
A1C49			NOT ASSIGNED		
A1C50	0180-C100	1	C:FXD ELECT 4.7 UF 10% 35VDCW	56289	150D475X9035B2-DYS
A1C51	0180-C228		C:FXD ELECT 22 UF 10% 15VDCW	56289	150D226X9015B2-DYS
A1CR1	1901-0040	7	DIODE:SILICON 30MA 30WV	07263	FDG1088
A1CR2	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A1CR3	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A1CR4	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A1CR5	1902-0777	1	DIODE:BREAKDOWN 6.2V 5%	04713	1N825
A1CR6	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A1CR7	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A1CR8	1901-0026	4	DIODE:SILICON 0.75A 200PIV	04713	SR1358-8
A1CR9	1901-0026		DIODE:SILICON 0.75A 200PIV	04713	SR1358-8
A1CR10	1901-0026		DIODE:SILICON 0.75A 200PIV	04713	SR1358-8
A1CR11	1901-0026		DIODE:SILICON 0.75A 200PIV	04713	SR1358-8
A1CR12	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A1IC1	1820-0216	1	INTEGRATED CIRCUIT:OPERATIONAL AMPL.	07263	SL8941
A1Q1	1855-0348	1	TSTR:SI FET N-CHANNEL	28480	1855-0348
A1Q2	1853-0066	5	TSTR:SI PNP	80131	2N4250
A1Q3	1854-0023	1	TSTR:SI NPN(SELECTED FROM 2N2484)	28480	1854-0023
A1Q4	1853-0066		TSTR:SI PNP	80131	2N4250
A1Q5	1853-0066		TSTR:SI PNP	80131	2N4250
A1Q6	1855-0062	1	TSTR:SI FET 30V	01295	2N1595
A1Q7	1853-0066		TSTR:SI PNP	80131	2N4250
A1Q8	1854-0071	15	TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A1Q9	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A1Q10	1853-0020	17	TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A1Q11	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A1Q12	1855-0052	2	TSTR:FET	80131	2N4360

Table 5-2. Replaceable Parts (Cont)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1Q13	1855-0052		TSTR:FET	80131	2N4360
A1Q14	1854-0221	1	TSTR:SI NPN(REPL.BY 2N4044)	28480	1854-0221
A1Q15	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A1Q16	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A1Q17	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A1Q18	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A1Q19	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A1Q20	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A1Q21	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A1Q22	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A1Q23	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A1Q24	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A1Q25	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A1Q26	1853-0027	1	TSTR:SI PNP	07263	S1554S
A1Q27	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A1Q28	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A1Q29	1854-0003	1	TSTR:SI NPN(SELECTED FROM 2N1711)	28480	1854-0003
A1Q30	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A1Q31	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A1Q32	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A1Q33	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A1Q34	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A1Q35	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A1Q36	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A1Q37	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A1Q38	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A1Q39	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A1Q40	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A1Q41	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A1Q42	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A1Q43	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A1Q44	1853-0066		TSTR:SI PNP	80131	2N4250
A1Q45	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A1R1	0683-1055	1	R:FXD COMP 1 MEGOHM 5% 1/4W	01121	CB 1055
A1R2	0757-0461	4	R:FXD MET FLM 68.1K OHM 1% 1/8W	28480	0757-0461
A1R3	0698-5855	1	R:FXD FLM 750 OHM 1% 1/4W	28480	0698-5855
A1R4	0698-3158	2	R:FXD MET FLM 23.7K OHM 1% 1/8W	28480	0698-3158
A1R5	0698-3158		R:FXD MET FLM 23.7K OHM 1% 1/8W	28480	0698-3158
A1R6	0698-5858	1	R:FXD FLM 383 OHM 1% 1/4W	28480	0698-5858
A1R7	0757-0460	1	R:FXD MET FLM 61.9K OHM 1% 1/8W	28480	0757-0460
A1R8	0757-0461		R:FXD MET FLM 68.1K OHM 1% 1/8W	28480	0757-0461
A1R9	0757-0199	3	R:FXD MET FLM 21.5K OHM 1% 1/8W	28480	0757-0199
A1R10			NOT ASSIGNED		
A1R12			NOT ASSIGNED		
A1R13	0757-0279	1	R:FXD MET FLM 3.16K OHM 1% 1/8W	28480	0757-0279
A1R14	0757-0466	1	R:FXD MET FLM 110K OHM 1% 1/8W	28480	0757-0466
A1R15	0698-3450	3	R:FXD MET FLM 42.2K OHM 1% 1/8W	28480	0698-3450
A1R16	0757-0470	2	R:FXD MET FLM 162K OHM 1% 1/8W	28480	0757-0470
A1R17	0698-3450		R:FXD MET FLM 42.2K OHM 1% 1/8W	28480	0698-3450
A1R18	0698-0085	3	R:FXD MET FLM 2.61K OHM 1% 1/8W	28480	0698-0085
A1R19	0757-0278	2	R:FXD MET FLM 1.78K OHM 1% 1/8W	28480	0757-0278
A1R20	0698-3453	1	R:FXD MET FLM 196K OHM 1% 1/8W	28480	0698-3453
A1R21	0757-0470		R:FXD MET FLM 162K OHM 1% 1/8W	28480	0757-0470
A1R22	0757-0461		R:FXD MET FLM 68.1K OHM 1% 1/8W	28480	0757-0461
A1R23	0698-3449	2	R:FXD MET FLM 28.7K OHM 1% 1/8W	28480	0698-3449
A1R24	0698-3449		R:FXD MET FLM 28.7K OHM 1% 1/8W	28480	0698-3449
A1R25	0757-0438	4	R:FXD MET FLM 5.11K OHM 1% 1/8W	28480	0757-0438
A1R26	0757-0438		R:FXD MET FLM 5.11K OHM 1% 1/8W	28480	0757-0438
A1R27	0698-3151	3	R:FXD MET FLM 2.87K OHM 1% 1/8W	28480	0698-3151
A1R28	0757-0444	4	R:FXD MET FLM 12.1K OHM 1% 1/8W	28480	0757-0444
A1R29	0698-3151		R:FXD MET FLM 2.87K OHM 1% 1/8W	28480	0698-3151
A1R30	0757-0444		R:FXD MET FLM 12.1K OHM 1% 1/8W	28480	0757-0444
A1R31	0698-3459	2	R:FXD MET FLM 383K OHM 1% 1/8W	28480	0698-3459
A1R32	2100-0943	1	R:VAR MET FLM 100K 20% LIN 3/4W	75042	CT150
A1R33	0698-3459		R:FXD MET FLM 383K OHM 1% 1/8W	28480	0698-3459
A1R34	0683-7545	1	R:FXD COMP 750K OHM 5% 1/4W	01121	CB 7545
A1R35	0757-0443	1	R:FXD MET FLM 11.0K OHM 1% 1/8W	28480	0757-0443
A1R36	0757-0444		R:FXD MET FLM 12.1K OHM 1% 1/8W	28480	0757-0444
A1R37	0757-0465	5	R:FXD MET FLM 100K OHM 1% 1/8W	28480	0757-0465
A1R38	0757-0458	7	R:FXD MET FLM 51.1K OHM 1% 1/8W	28480	0757-0458
A1R39	0757-0280	5	R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
A1R40	0757-0346	1	R:FXD MET FLM 10 OHM 1% 1/8W	28480	0757-0346
A1R41	0757-0419	1	R:FXD MET FLM 681 OHM 1% 1/8W	28480	0757-0419
A1R42	0757-0399	1	R:FXD MET FLM 82.5 OHM 1% 1/8W	28480	0757-0399
A1R43	2100-1771	1	R:VAR WW 200 OHM 5% TYPE H 1W	28480	2100-1771

See introduction to this section for ordering information

Table 5-2. Replaceable Parts (Cont)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1R44	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
A1R45			NOT ASSIGNED		
A1R50			NOT ASSIGNED		
A1R51	0757-0463	2	R:FXD MET FLM 82.5K OHM 1% 1/8W	28480	0757-0463
A1R52	0757-0463		R:FXD MET FLM 82.5K OHM 1% 1/8W	28480	0757-0463
A1R53	0757-0459	2	R:FXD MET FLM 56.2K OHM 1% 1/8W	28480	0757-0459
A1R54	0757-0199		R:FXD MET FLM 21.5K OHM 1% 1/8W	28480	0757-0199
A1R55	0757-0401	8	R:FXD MET FLM 100 OHM 1% 1/8W	28480	0757-0401
A1R56	0698-3442	3	R:FXD MET FLM 237 OHM 1% 1/8W	28480	0698-3442
A1R57	0757-0401		R:FXD MET FLM 100 OHM 1% 1/8W	28480	0757-0401
A1R58	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
A1R59	0757-0458		R:FXD MET FLM 51.1K OHM 1% 1/8W	28480	0757-0458
A1R60	0757-0401		R:FXD MET FLM 100 OHM 1% 1/8W	28480	0757-0401
A1R61	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
A1R62	0757-0458		R:FXD MET FLM 51.1K OHM 1% 1/8W	28480	0757-0458
A1R63	0698-3442		R:FXD MET FLM 237 OHM 1% 1/8W	28480	0698-3442
A1R64	0757-0199		R:FXD MET FLM 21.5K OHM 1% 1/8W	28480	0757-0199
A1R65	0757-0401		R:FXD MET FLM 100 OHM 1% 1/8W	28480	0757-0401
A1R66	0757-0459		R:FXD MET FLM 56.2K OHM 1% 1/8W	28480	0757-0459
A1R67	0698-3451	1	R:FXD MET FLM 133K OHM 1% 1/8W	28480	0698-3451
A1R68	2100-1772	1	R:VAR WW 200 OHM 5% TYPE H 1W	28480	2100-1774
A1R69	0698-3155	1	R:FXD MET FLM 4.64K OHM 1% 1/8W	28480	0698-3155
A1R70	0757-0465		R:FXD MET FLM 100K OHM 1% 1/8W	28480	0757-0465
A1R71	0698-3460	1	R:FXD MET FLM 422K OHM 1% 1/8W	28480	0698-3460
A1R72	0698-3450		R:FXD MET FLM 42.2K OHM 1% 1/8W	28480	0698-3450
A1R73	0698-0085		R:FXD MET FLM 2.61K OHM 1% 1/8W	28480	0698-0085
A1R74	0698-3162	2	R:FXD MET FLM 46.4K OHM 1% 1/8W	28480	0698-3162
A1R75	0757-0401		R:FXD MET FLM 100 OHM 1% 1/8W	28480	0757-0401
A1R76	0698-8029	2	R:FXD MET FLM 2.15 MEGOHM 1% 1/2W	28480	0698-8029
A1R77	0698-3439	3	R:FXD MET FLM 178 OHM 1% 1/8W	28480	0698-3439
A1R78	0698-3439		R:FXD MET FLM 178 OHM 1% 1/8W	28480	0698-3439
A1R79	0698-3162		R:FXD MET FLM 46.4K OHM 1% 1/8W	28480	0698-3162
A1R80	0757-0401		R:FXD MET FLM 100 OHM 1% 1/8W	28480	0757-0401
A1R81	0698-8029		R:FXD MET FLM 2.15 MEGOHM 1% 1/2W	28480	0698-8029
A1R82	0757-0379	1	R:FXD MET FLM 12.1 OHM 1% 1/8W	28480	
A1R83	0698-0085		R:FXD MET FLM 2.61K OHM 1% 1/8W	28480	0698-0085
A1R84	0698-3156	3	R:FXD MET FLM 14.7K OHM 1% 1/8W	28480	0698-3156
A1R85	0698-3430	1	R:FXD MET FLM 21.5 OHM 1% 1/8W	28480	0698-3430
A1R86	0757-0290	2	R:FXD MET FLM 6.19K OHM 1% 1/8W	28480	0757-0290
A1R87			NOT ASSIGNED		
A1R88	0757-0290		R:FXD MET FLM 6.19K OHM 1% 1/8W	28480	0757-0290
A1R89	0757-0442	1	R:FXD MET FLM 10.0K OHM 1% 1/8W	28480	0757-0442
A1R90			NOT ASSIGNED		
A1R91	0757-0288	1	R:FXD MET FLM 9.09K OHM 1% 1/8W	28480	0757-0288
A1R92	0757-0278		R:FXD MET FLM 1.78K OHM 1% 1/8W	28480	0757-0278
A1R93	0698-3136	1	R:FXD MET FLM 17.8K OHM 1% 1/8W	28480	0698-3136
A1R94	0757-0447	1	R:FXD MET FLM 16.2K OHM 1% 1/8W	28480	0757-0447
A1R95	0757-0458		R:FXD MET FLM 51.1K OHM 1% 1/8W	28480	0757-0458
A1R96	2100-1777	1	R:VAR WW 20K OHM 5% TYPE H 1W	28480	2100-1777
A1R97	0757-0458		R:FXD MET FLM 51.1K OHM 1% 1/8W	28480	0757-0458
A1R98	0698-3156		R:FXD MET FLM 14.7K OHM 1% 1/8W	28480	0698-3156
A1R99	2100-1772	1	R:VAR WW 500 OHM 5% TYPE H 1W	28480	2100-1772
A1R100	0757-0420	1	R:FXD MET FLM 750 OHM 1% 1/8W	28480	0757-0420
A1R101	0698-0083	1	R:FXD MET FLM 1.96K OHM 1% 1/8W	28480	0698-0083
A1R102	0757-0465		R:FXD MET FLM 100K OHM 1% 1/8W	28480	0757-0465
A1R103	0757-0444		R:FXD MET FLM 12.1K OHM 1% 1/8W	28480	0757-0444
A1R104	0698-3153		R:FXD MET FLM 3.83K OHM 1% 1/8W	28480	0698-3153
A1R105	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
A1R106	0698-3151		R:FXD MET FLM 2.87K OHM 1% 1/8W	28480	0698-3151
A1R107	0757-0317	1	R:FXD MET FLM 1.33K OHM 1% 1/8W	28480	0757-0317
A1R108	0698-3442		R:FXD MET FLM 237 OHM 1% 1/8W	28480	0698-3442
A1R109	0698-3439		R:FXD MET FLM 178 OHM 1% 1/8W	28480	0698-3439
A1R110			NOT ASSIGNED		
A1R111			NOT ASSIGNED		
A1R112	0757-0438		R:FXD MET FLM 5.11K OHM 1% 1/8W	28480	0757-0438
A1R113	0698-3154	1	R:FXD MET FLM 4.22K OHM 1% 1/8W	28480	0698-3154
A1R114			NOT ASSIGNED		
A1R115	0757-0465		R:FXD MET FLM 100K OHM 1% 1/8W	28480	0757-0465
A1R116	0757-0465		R:FXD MET FLM 100K OHM 1% 1/8W	28480	0757-0465
A1R117	0757-0458		R:FXD MET FLM 51.1K OHM 1% 1/8W	28480	0757-0458
A1R118	0757-0461		R:FXD MET FLM 68.1K OHM 1% 1/8W	28480	0757-0461
A1T1	0839-0011	1	THERMISTOR:100 OHM 10%	33173	2D-204
A2	08330-60002	1	BOARD ASSY:SLIDE SWITCH	28480	08330-60002
A2	5020-3440	4	SPRING:DETENT	28480	5020-3440

Table 5-2. Replaceable Parts (Cont)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A2	08330-40002	1	HOLDER:SPRING	28480	08330-40002
A2	08330-60012	1	SLIDE ASSY:2 ROW 8 POSITION	28480	08330-60012
A2	08330-60013	1	SLIDE ASSY:4 ROW 16 POSITION	28480	08330-60013
A2	08330-60014	1	SLIDE ASSY:4 ROW 28 POSITION	28480	08330-60014
A2C1	0180-0229	1	C:FXD ELECT 33 UF 10% 10VDCW	28480	0180-0229
A2C2	0180-0161	1	C:FXD ELECT 3.3 UF 20% 35VDCW	56289	150D335X0035B2-DYS
A2C3	0180-0137	1	C:FXD ELECT 100 UF 20% 10VDCW	56289	150D107X0010R2-DYS
A2C4			NOT ASSIGNED		
A2C5			NOT ASSIGNED		
A2C6			NOT ASSIGNED		
A2C7	0180-0197		C:FXD ELECT 2.2 UF 10% 20VDCW	56289	150D225X9020A2-DYS
A2C8	0180-0197		C:FXD ELECT 2.2 UF 10% 20VDCW	56289	150D225X9020A2-DYS
A2C9	0160-0665	1	C:FXD MY 0.33 UF 10% 80VDCW	28480	0160-0889
A2R1	0698-8030	1	R:FXD FLM 31.65K OHM 1% 1/8W	28480	J30
A2R2	0698-4343	1	R:FXD FLM 100 OHM 0.1% 1/8W	28480	0698-4343
A2R3	0698-7300	1	R:FXD FLM 21.62K OHM 0.1% 1/8W	28480	0698-7300
A2R4	0698-7296	1	R:FXD FLM 6.838K OHM 0.1% 1/8W	28480	0698-7296
A2R5	0698-7297	1	R:FXD FLM 2.162K OHM 0.1% 1/8W	28480	0698-7297
A2R6			NOT ASSIGNED		
A2R7	0698-7298	1	R:FXD FLM 683.8 OHM 0.1% 1/8W	28480	0698-7298
A2R8			NOT ASSIGNED		
A2R9	0698-3260	5	R:FXD MET FLM 464K OHM 1% 1/8W	28480	0698-3260
A2R10	0698-3260		R:FXD MET FLM 464K OHM 1% 1/8W	28480	0698-3260
A2R11	0698-3260		R:FXD MET FLM 464K OHM 1% 1/8W	28480	0698-3260
A2R12	0698-3153		R:FXD MET FLM 3.83K OHM 1% 1/8W	28480	0698-3153
A2R13			NOT ASSIGNED		
A2R14	0757-0384	10	R:FXD FLM 20 OHM 1% 1/8W	28480	0757-0384
A2R15	0757-0384		R:FXD FLM 20 OHM 1% 1/8W	28480	0757-0384
A2R16	0757-0384		R:FXD FLM 20 OHM 1% 1/8W	28480	0757-0384
A2R17	0757-0384		R:FXD FLM 20 OHM 1% 1/8W	28480	0757-0384
A2R18	0757-0384		R:FXD FLM 20 OHM 1% 1/8W	28480	0757-0384
A2R19	0757-0384		R:FXD FLM 20 OHM 1% 1/8W	28480	0757-0384
A2R20	0757-0384		R:FXD FLM 20 OHM 1% 1/8W	28480	0757-0384
A2R21	0757-0384		R:FXD FLM 20 OHM 1% 1/8W	28480	0757-0384
A2R22	0757-0384		R:FXD FLM 20 OHM 1% 1/8W	28480	0757-0384
A2R23	0757-0384		R:FXD FLM 20 OHM 1% 1/8W	28480	0757-0384
A2R24	0757-0486	1	R:FXD MET FLM 750K OHM 1% 1/8W	28480	0757-0486
A2R25			NOT ASSIGNED		
A2R26			NOT ASSIGNED		
A2R27	0683-1565	1	R:FXD COMP 15 MEGOHM 5% 1/4W	01121	CB 1565
A2R28	0698-7585	1	R:FXD MW 316.2 OHM 0.1% 1/8W	28480	0698-7585
A3	08330-60005	1	HOUSING ASSY:ZERO-CAL	28480	08330-60005
A3			THIS ASSY IS A SEALED UNIT, N.S.R.		
C1	0160-3043	1	C:FXD CER 2 X 0.005 UF 20% 250VAC	56289	29C147A-CDH
F1	2110-0027	1	FUSE:0.125A 250V	75915	312.125
G1	0490-0797	1	CHOPPER:AC-DC SPDT	80640	CH-1546-110
J1			NOT ASSIGNED		
J2	1250-0083	2	CONNECTOR:BNC	02660	31-221-1020
J3			NOT ASSIGNED		
J4	1250-0083		CONNECTOR:BNC	02660	31-221-1020
M1	1120-1533	1	METER:1.0 MA	28480	1120-1533
R1	0757-0401		R:FXD MET FLM 100 OHM 1% 1/8W	28480	0757-0401
R2	0757-0401		R:FXD MET FLM 100 OHM 1% 1/8W	28480	0757-0401
R4	0698-3260		R:FXD MET FLM 464K OHM 1% 1/8W	28480	0698-3260
R5	0698-3260		R:FXD MET FLM 464K OHM 1% 1/8W	28480	0698-3260
R6	0757-0438		R:FXD MET FLM 5.11K OHM 1% 1/8W	28480	0757-0438
R7	0698-3156		R:FXD MET FLM 14.7K OHM 1% 1/8W	28480	0698-3156
R8	0698-6377	2	R:FXD FLM 200 OHM 0.1% 1/8W	28480	0698-6377
R9	0698-8052	1	R:FXD FLM 590 OHM 0.1% 1/8W	28480	0698-8052
R10	0698-6377		R:FXD FLM 200 OHM 0.1% 1/8W	28480	0698-6377
S1	3101-1602	1	SWITCH: TOGGLE	87034	53-55480-120/A1H
S2	3101-0070	1	SWITCH:SLIDE	79727	G-126
S3	3101-0903	1	SWITCH:SLIDE DP3T 0.5A 125V AC/DC	79727	G128S-0003
T1	9100-2853	1	TRANSFORMER	28480	9100-2853
T2	9100-2844	1	TRANSFORMER:INPUT	28480	9100-2844
XA3	08330-60011	1	BOARD ASSY:TERMINAL	28480	08330-60011
XF1	1400-0084	1	FUSEHOLDER:EXTRACTOR POST TYPE	75915	342014
XJ1	1250-1151	1	BUSHING:RF CONNECTOR NYLON	00779	331025
			CHASSIS PARTS		
	8120-1348	1	CABLE ASSY:POWER, DETACHABLE	70903	KHS-7041
	08330-00004	1	SHIELD:THERMAL	28480	08330-00004
	08330-20005	1	PLATE:THERMAL	28480	08330-20005
	08330-60006	1	CABLE ASSY:POWER	28480	08330-60006
	08330-60007	1	CABLE ASSY:RELAY	28480	08330-60007
	00432-2003	1	NUT, DRESS		

See introduction to this section for ordering information

Table 5-2. Replaceable Parts (Cont)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
	08330-60008	1	CABLE ASSY:2 NP AMP	28480	08330-60008
	08330-60009	1	CONNECTOR ASSY:INPUT	28480	08330-60009
			CABINET PARTS		
12	1490-0031	1	STAND:TILT	28480	1490-0031
3	5000-0703	2	SIDE COVER	28480	5000-0703
11	5000-0711	1	COVER:BOTTOM	28480	5000-0711
5	5020-0704	1	METER TRIM:THIRD MOD.	28480	5020-0704
6	5040-0700	2	HINGE	28480	5040-0700
4	5060-0703	2	FRAME ASSY:6 X 11 SM	28480	5060-0703
7	5060-0709	1	COVER ASSY:TOP 5 X 11 SM	28480	5060-0709
9	5060-0727	1	FOOT ASSY	28480	5060-0727
10	08330-00001	1	PANEL:FRONT	28480	08330-00001
8	08330-00002	1	PANEL:REAR	28480	08330-00002
2	08330-00003	1	DECK	28480	08330-00003

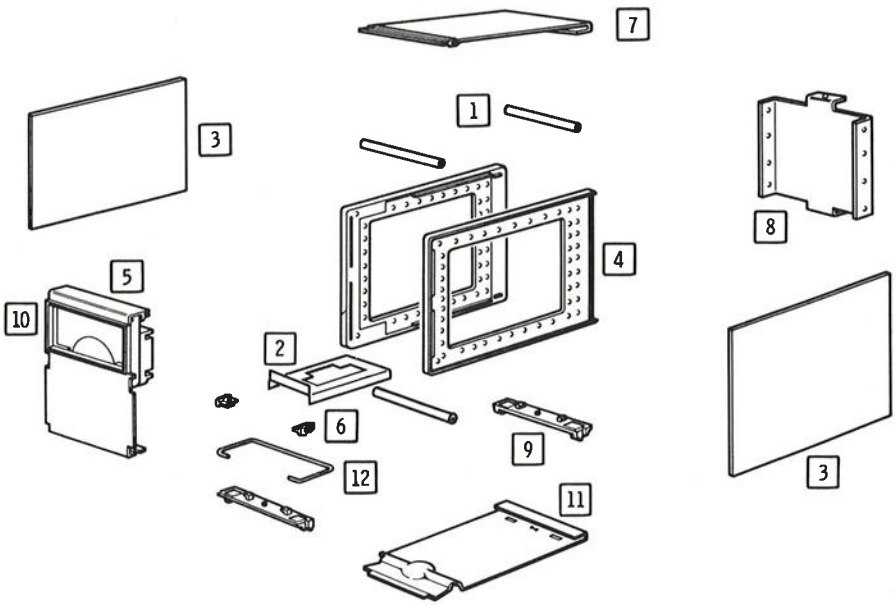


Table 5-3. Code List of Manufacturers

The following code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) and their latest supplements.

Code No.	Manufacturer	Address	Zip Code
00779	AMP Inc. (Aircraft Marine Prod.)	Harrisburg, Pa.	17101
01121	Allen Bradley Co.	Milwaukee, Wis.	53204
01295	Texas Instruments Inc. Semiconductor Components Div.	Dallas, Texas	75231
02660	Amphenol Corp.	Broadview, Ill.	60153
04713	Motorola Semiconductor Prod. Inc.	Phoenix, Ariz.	85008
07263	Fairchild Camera & Inst. Corp., Semiconductor Div.	Mountain View, CA	94040
28480	Hewlett-Packard Company	Palo Alto, CA	94304
33173	G.E. Co. Tube Dept.	Owensboro, Kty.	42301
56289	Sprague Electric Co.	N. Adams, Mass.	01247
70903	Belden Corp.	Chicago, Ill.	60644
75042	International Resistance Co. Inc.	Philadelphia, Pa.	19108
75915	Littelfuse Inc.	Des Plaines, Ill.	60016
79727	Continental-Wirt Electronics Corp.	Philadelphia, Pa.	19144
80131	Electronic Industries Association Standard tube or semiconductor device, any manufacturer.	Washington, D.C.	20006
80640	Stevens, Arnold Inc.	S. Boston, Mass.	02127
84411	TRW Capacitor Div.	Ogallala, Nebr.	69153
87034	Marco & Oak Industries Div. Oak Electro/Netics Corp.	Anaheim, CA	92803
91418	Radio Materials Co.	Chicago, Ill.	60646

SECTION VI
SERVICE

6-1. INTRODUCTION

6-2. This section contains the theory of operation, troubleshooting instructions, schematics, and component locations for the Model 8330A Radiant Flux Meter.

6-3. TROUBLESHOOTING

6-4. Service Sheets (SS) 1 through 6 contain overall and detailed troubleshooting charts. Procedures for isolating circuit malfunctions to a specific stage are based on the overall troubleshooting chart in SS-1.

6-5. Table 1A, Service Sheet 1, contains the overall troubleshooting table that directs the user to the troubleshooting charts in Service Sheets 2 through 6. In a few instances certain specific parts are called out as a probable cause of circuit malfunction, however, the troubleshooting charts are not intended to locate specific parts that have failed. They are intended to locate malfunctioning stages only.

6-6. SCHEMATICS

6-7. The schematics contain signal-routing information, nominal voltage levels, waveforms, and notes that assist in understanding the circuit. They show electrical operation and are not intended as wiring diagrams. Component location photographs next to the schematic foldouts indicate the physical location of the parts. Test points are also shown in the photograph as well as on the schematic. Table 6-3, Schematic Diagram Notes, shows the front panel setting and test conditions that existed when the nominal voltages and the waveforms were taken.

6-8. TEST EQUIPMENT AND ACCESSORIES REQUIRED

6-9. Test equipment and accessories required to troubleshoot the Model 8330A Radiant Flux Meter are shown in Table 6-1 and Table 6-2. Test instruments other than those listed may be used provided that their specifications meet or exceed those listed in Table 6-1.

Table 6-1. Recommended Test Equipment

Instrument Type	Critical Specifications	Recommended Model
True RMS AC Meter	Accuracy: ±0.08% of reading +0.02% of range, 90 days, (25°C ±5°C) Input Impedance: a megohm, shunted by 90 pF Balanced and Floating Resolution: Five Digits	HP 3450A or HP 3480/3484
DC Digital Voltmeter	Accuracy: ±.05% of reading. Input Impedance: 10 megohm	HP 3450A; 3440A/3443A
AC Voltmeter	Accuracy: at least ±2% at 120 Hz. Range: .001 to 300V	HP 400C/E/F
Range Calibrator	Range: 3 μW to 100 mW/cm^2 Output Impedance: 474 ohms ±0.1%	HP 11594A
Oscilloscope	Sensitivity: 5 mW/div Input Impedance: 1 megohm	HP 180A or 180AR
	General purpose time base with internal trigger	HP 1820A
Detector	Operating Resistance: 474 ohms	HP 8334A

Table 6-2. Recommended Accessories

Item	Description	Recommended Model
Adapter	BNC male to binding post	HP 10110A
Adapter	BNC female to binding post	HP 10111A
Cable	4 foot, 50-ohm coaxial cable terminated with BNC male connectors	HP 10503A
Test Leads	5 foot, dual banana plug to alligator clips	HP 11002A
Oscilloscope Probe	10:1 Divider, 10 megohm resistance, 10 pF capacitor	HP 10004A
Screwdriver	Pozidriv #1 (small)	HP 8710-0899

6-10. REPAIR

6-11. Parts Location Aids

6-12. The location of chassis parts are shown in Figures 6-4 through 6-7. The location of individual components mounted on printed boards or other assemblies are shown on the appropriate service sheet page. The parts reference designator is the assembly designator plus the part designator. (Example: A1R9 is R9 on the A1 amplifier assembly.) Refer to the parts list in Section V for specific component description in ordering information.

6-13. Factory Selected Components

6-14. Some component values are selected at the time of final checkout at the factory. Usually these values are not extremely critical; they are selected to provide optimum compatibility with associated components. These components are identified in individual schematics by an asterisk (*). The recommended procedure for replacing a factory selected part is as follows:

a. Try the original value, then perform the calibration tests specified for the circuit in the calibration and adjustment section.

b. If calibration cannot be accomplished, try the typical value shown in the parts list and repeat the test.

c. If calibration still cannot be accomplished, perform the calibration tests using various values until calibration is accomplished.

6-15. ASSEMBLY EXCHANGE PROGRAM

6-16. The A2 switching assembly for the Model 8330A is available on an exchange basis at a considerable savings in cost. Simply contact the Hewlett-Packard Office nearest you and make your requirements known. The local Hewlett-Packard Office will arrange for immediate Air Mail shipment to minimize equipment downtime. At least 90% of orders for replacement parts received by a HP Service Office will be shipped the same day; either from the Sales Office itself or from a Service Center. The factory-repaired exchange circuit boards should be ordered by the special part number appearing in Table 5-2 of this manual. See Figure 6-1 for removal and replacement of the A2 Switching circuit.

REMOVAL OF A2 SWITCHING ASSEMBLY

Remove the eight screws that hold the side covers on the instrument. Remove the right side cover (see Figure 6-1 A). Remove the bottom cover. Remove the 11 screws that hold the side frame to the instrument. Lift the side frame away from the instrument (see Figure 6-1 B). Back off the two meter screws on the other side panel. Lift the bottom portion of the front panel from the alignment slots on the bottom side frame. Tilt the front panel slightly to the left. Remove the three screws that hold the A2 Switching assembly to the front panel and separate the front panel and switching assembly. Remove the leads from the old switching assembly and place them on the new switching assembly.

CAUTION

Make sure that the wire color codes and the numbers on the switching assembly match.

REPLACEMENT OF THE A2 SWITCHING ASSEMBLY

Put the new switching assembly on the front panel making sure that the slide switches fit through the holes on the front panel. Replace the three screws that hold the assembly to the front panel. Insert the front panel into the alignment slot (see Figure 6-1 C) on the bottom side frame. Replace the top side frame making sure that the front panel fits into the alignment slot. Replace the 11 screws that secure the side panel. Replace the side cover.

Figure 6-1. Removal and Replacement of the A2 Switching Assembly (Sheet 1 of 2)

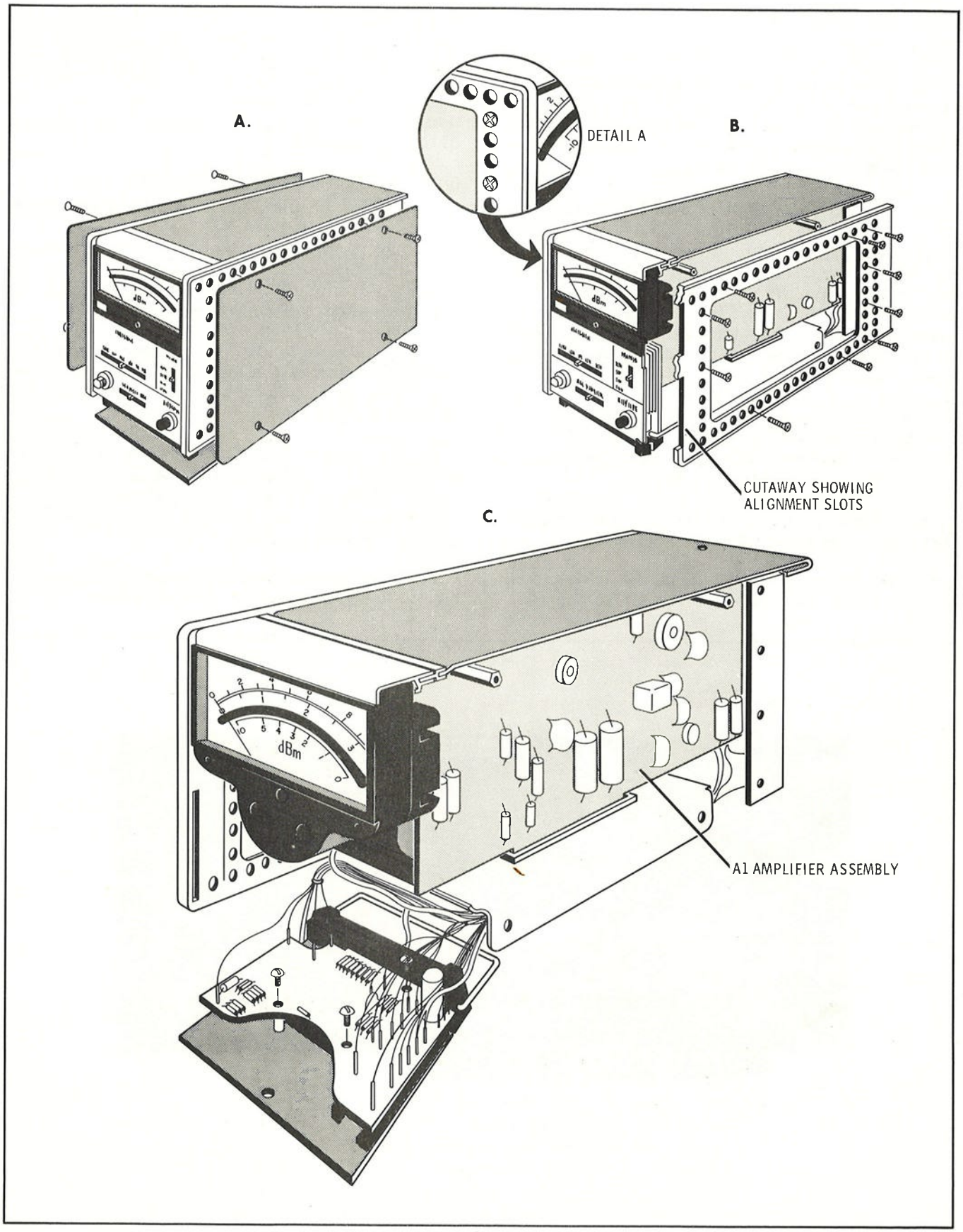


Figure 6-1. Removal and Replacement of the A2 Switching Assembly (Sheet 2 of 2)

6-17. DIAGRAM NOTES

6-18. Table 6-3, Schematic Diagram Notes, provides information relating to symbols and values shown in the schematic diagrams. This table also contains the test conditions and front panel setting under which the nominal voltages and waveforms were taken.

6-19. ZERO/CAL CIRCUIT REPLACEMENT

6-20. The Zero/Cal circuit cannot be repaired in the field. If the circuit is not operating (see Figure 5C, SS-5) remove the wires from XA3 and the two screws holding the circuit to the thermal block. To install a new circuit, run the wires through the hole in the thermal block and connect them to XA3.

CAUTION

Make sure that the color code on the wires and the numbers on XA3 match.

a. Replace the two screws that hold the circuit to the thermal block. Connect a Model 8334A Detector to the front of the Model 8330A.

b. Place the Model 8330A in the CAL mode; the needle on the meter should go to the CAL mark. Place the Model 8330A in the ZERO mode; the instrument should zero. If the instrument does not function in either of these two modes, refer to the overall troubleshooting table (Table 1A, SS-1). Perform the Performance Test given in Section IV, Paragraph 4-11, to ensure proper operation of the Model 8330A.

6-21. SERVICING MODEL 8330A INPUT CIRCUIT MECHANICAL CONNECTORS

6-22. To prevent unwanted thermocouple voltages from being generated in the input circuits (see Figure 6-2) the following procedures should be observed when servicing these circuits.

a. The screws holding the copper lugs must be insulated from the thermal block. This is accomplished by using non-metallic (mica) washers (HP Stock No. 3052-0443).

b. The copper lugs must be isolated from the screw. This is accomplished by using teflon tubing on the screw shaft and a non-metallic washer between the copper lugs and the nut. The HP Stock No. for the teflon tubing is 0890-0026.

c. If a copper lug (HP Stock No. 0362-0240) has to be replaced (see 98410, Table 5-3, for

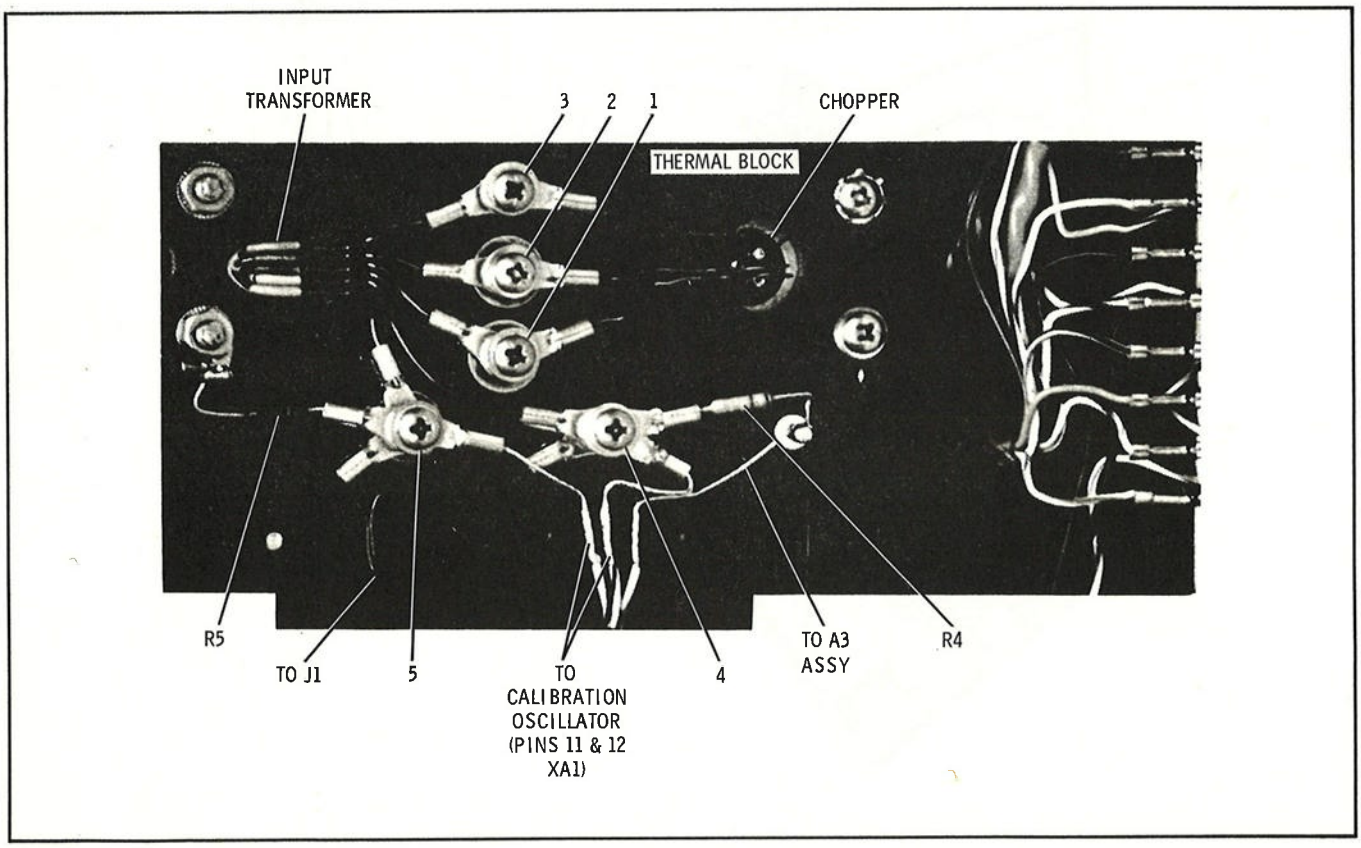


Figure 6-2. Model 8330A Input Circuits

manufacturer), make sure that a mechanical crimp is made. This provides solid mechanical contact. Do not solder these connections, as unwanted thermal voltages will be developed.

d. Clean all copper lugs with Freon TF Degreaser (see 18589, Table 5-3 for manufacturer) before placing them on the screws.

e. Orientation of wires should be close to the position set at the factory to reduce susceptibility to ac fields.

6-23. Not Used.

6-25. IC SERVICING

6-26. The following procedure can be used to check U1 on SS-5. This procedure will determine if the IC is functioning properly.

a. Connect a low voltage power supply to Pin R of XA1; set the power supply to zero (0) volts.

b. Connect a DVM to A1TP 11; set the DVM range to AUTO or 100V. Hold the Model 8330A MODE switch in the CAL position; the DVM should indicate about +13 volts.

c. Set the power supply to +2 volts, hold the Model 8330A MODE switch in the CAL position. The change in voltage should change the state of the IC. The DVM should now indicate about −14 volts.

d. The IC is working properly if the above DVM readings are correct. If the IC fails to switch states as the inverting input is changed from 0 to +2 volts the following voltage measurements should be verified before replacing the IC.

(1) Measure +16V at Pin 7 of U1.

(2) Measure −16V at Pin 4 of U1.

(3) Measure +1V reference at Pin 14 of XA1 with the MODE switch in the CAL position.

Table 6-3. Schematic Diagram Notes

1. Resistance in ohms, capacitance in microfarads unless otherwise indicated.

2. Screwdriver adjustment. ○ Front panel control.

3. Front panel designation. Rear panel designation.

4. Printed circuit card holder. Main signal path.
   Secondary signal path. Secondary feedback path.

5. P/O = part of.

6. CW Wiper moves toward cw when control rotated clockwise.

7. Numbered, starred test points are identified posts on the circuit board.

8. Breakdown diode.

9. G D S N-Type Field Effect transistor (FET)
   G D S P-Type Field Effect transistor (FET)

10. G D S SUBSTRATE P-Type Metal Oxide Substrate FET (MOSFET)
    G D S SUBSTRATE N-Type Metal Oxide Substrate FET (MOSFET)

11. Encloses wire color code, e.g., (947) denotes white, yellow and violet (first number body color, second number wide stripe, third number thin stripe.

12. XA1 4 Indicates socket connections and pin numbers.

13. Wire jumper in power supply. Used to measure current with 1110A Current Probe.

14. TEST CONDITIONS

a. Waveforms - Waveforms were taken with an 11594A Range Calibrator connected to the 8330A. The 8330A controls were set as follows:

RANGE	100 mW/cm^2
CAL FACTOR %	100%, 80–100% Range
MODE	OPERATE

The 11594A RANGE switch was placed in the 100 mW position.

b. Voltages - The bias voltages listed are nominal voltage and were taken under the following conditions.

An 11594A Range Calibrator was connected to the front of the 8330A and controls were set as follows:

8330A

RANGE	100 mW/cm^2
CAL FACTOR %	100%, 80–100% Range
MODE	OPERATE

11594A

RANGE	OFF

.395 mW, the comparator reduces it to the correct level by lowering the Q of the oscillator tank. If the output is below .395 mW, the comparator raises the Q of the tank, which raises the amplitude of the oscillator signal.

13 The +16 volt regulator consists of a reference diode, sensing amplifier, control amplifier, and series regulator. The sensing amplifier compares the series regulator output with the reference diode. Any difference is amplified and used to drive the control amplifier. The control amplifier determines the drive to the series regulator, thus controlling the output voltage from the series regulator.

14 The –16 volt regulator, which consists of the sensing amplifier, control amplifier, and series regulator, is referenced to the +16V supply. Any difference voltage at the comparison point is amplified by the sensing amplifier and coupled to the control amplifier. This amplifier determines the output of the series regulator. Current limiting protects both the negative and positive supplies from overloads.

15 The decoupling networks provide various filtered positive and negative dc voltage to the Model 8330A circuits.

16 The relay driver provides control of the reed relays in the Zero/Cal circuit. These relays are activated in the ZERO and CAL modes of operation.

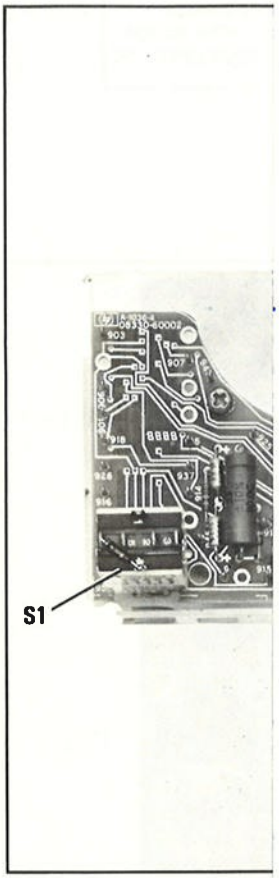


Figure 6-4.

ALL TROUBLESHOOTING

MEASUREMENT CONDITIONS:

a. Waveforms

Model 8330A

CAL FACTOR % . . 100%, 80—100% Range
MODE . . . . . OPERATE
RANGE . . . . . 100 mW/cm²

11594A

RANGE . . . . . 100 mW/cm²

b. Voltage

Model 8330A

CAL FACTOR %. . . 100%, 80—100% Range
MODE . . . . . OPERATE
RANGE . . . . . 100 mW/cm²

11594A

RANGE . . . . . OFF

All measurements made with respect to the chassis.

◀ *Figures 6-4 through*

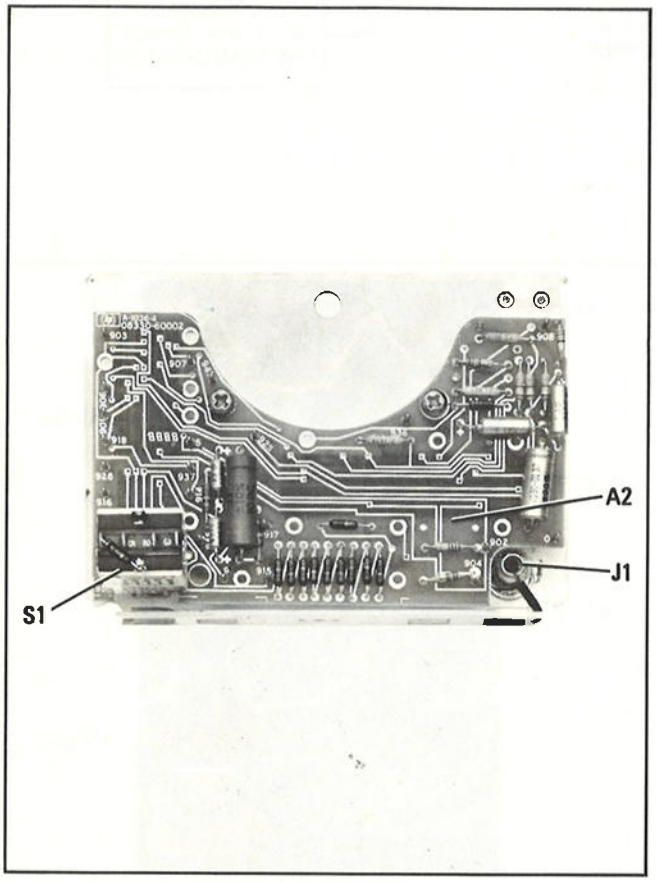


Figure 6-4. Front Panel Interior

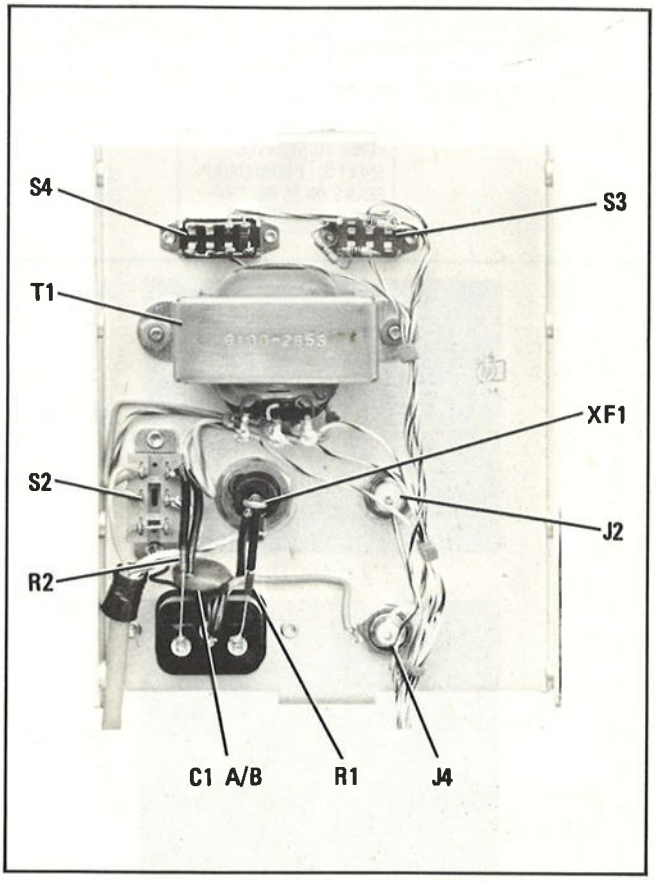


Figure 6-5. Rear Panel Interior

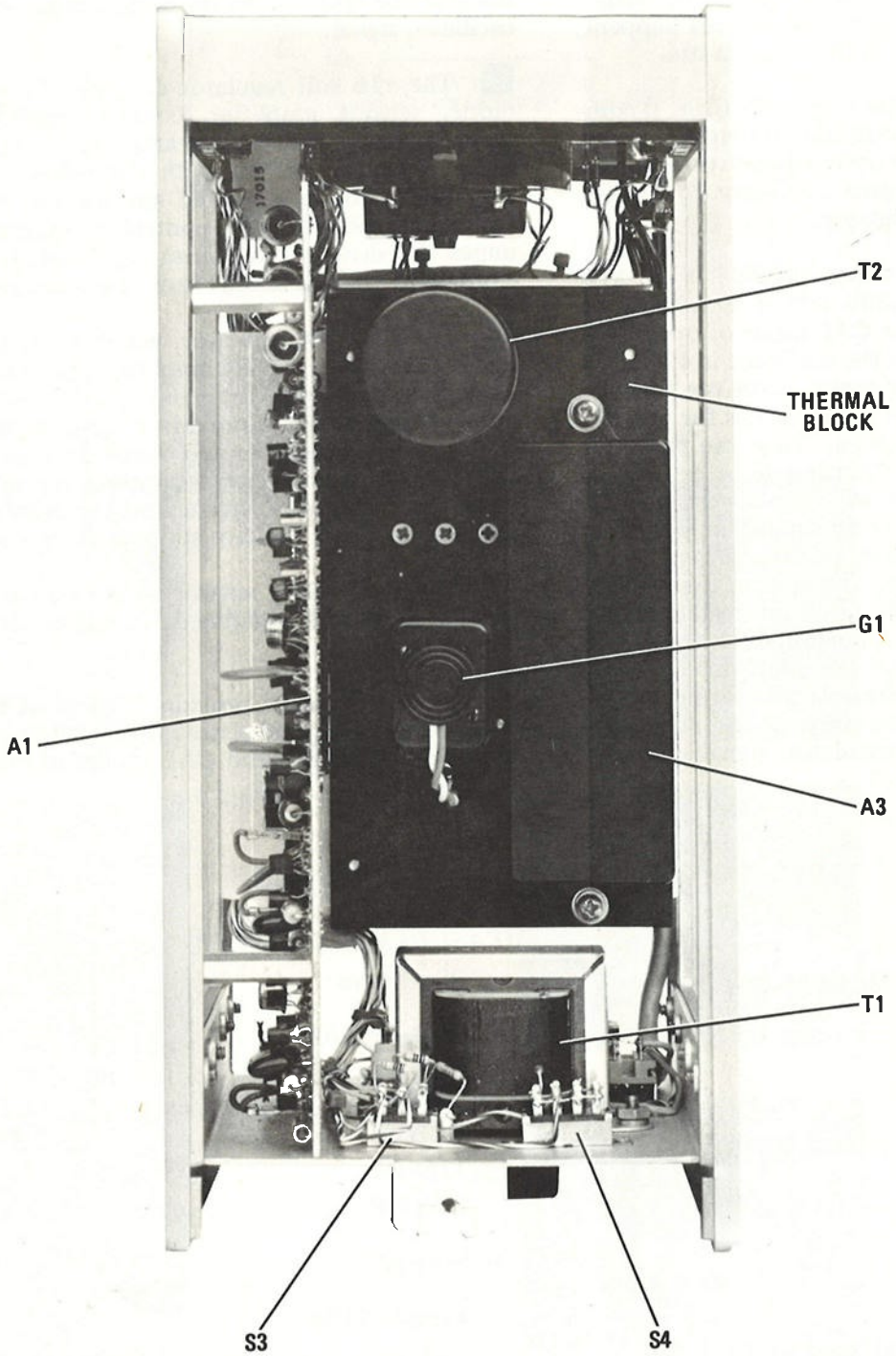


Figure 6-6. Top View, Cover Removed

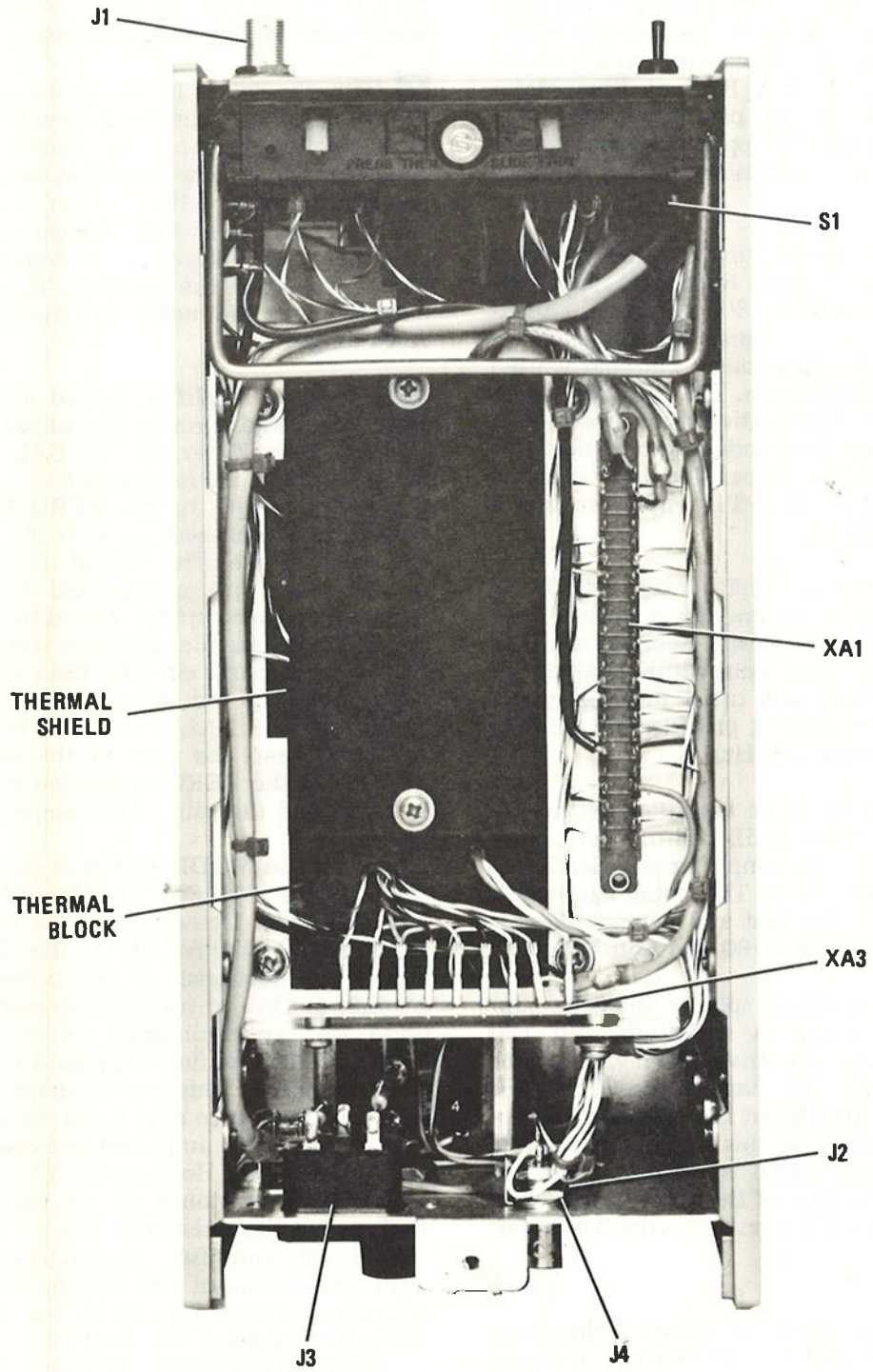


Figure 6-7. Bottom View, Cover Removed

SERVICE SHEET 1

1 Radiant energy incident on the detector is absorbed by the blackened thermopile junctions and reflected from the others causing a temperature difference and, thus, generation of a thermoelectric voltage. This dc voltage is coupled to the input of the Model 8330A Radiant Flux Meter where it is fed into a low pass filter. All input connections are copper-to-copper crimp connectors and are mounted on a common thermal block to minimize drift.

2 The dc voltage passes through the low-pass filter to the chopper. On the 3 $\mu W/cm^2$ range, the dc voltage is approximately 300 nanovolts. Accurate amplification of dc signals in this range is presently impractical; therefore a chopper is used to make a dc-to-ac conversion. The chopper, which is driven by the 107 Hz multivibrator, produces a 107 Hz signal whose amplitude is proportional to the dc voltage from the probe. The 107 Hz signal is applied to the primary of T1, which provides a voltage step-up of 50.

3 The first low-noise ac amplifier uses a FET and transistor combination to provide a voltage gain of 7. This amplifier, along with Section A of the variable attenuator, uses bandwidth shaping to attenuate stray pick-up and other interfering signals. This bandwidth shaping provides a 6 dB roll-off per octave at 60 and 180 Hz.

4 The second low-noise ac amplifier provides a gain of 130. Additional 6 dB roll-off per octave is provided by the second amplifier and Section B of the variable attenuator. The total bandwidth shaping provided by the first and second stages is 12 dB roll-off per octave at 60 and 180 Hz.

5 The variable gain phase splitter amplifier supplies two signals, equal in amplitude and 180 degrees out-of-phase, to drive the synchronous demodulator. Gain of this stage in the OPERATE mode is nominally 10 dB but is modified as necessary in the CAL mode. In this mode, the variable resistance FET stage, which is driven by the Cal Hold circuit, sets the gain of the amplifier to automatically calibrate the instrument on the 3 mW/cm^2 range.

6 The synchronous detector, which is driven by the 107 Hz multivibrator, converts the ac signal from the variable gain amplifier into a dc voltage. Response time and bandwidth of the detector change depending upon the position of the RANGE switch. For the lower three ranges the bandwidth is approximately 0.3 Hz and the response time is 2.7 seconds. This allows the instrument time to respond to the signal, yet reduces the effects of noise. On the 100, 300 $\mu W/cm^2$ and 1 mW/cm^2 ranges, bandwidth is 1.5 Hz and response time is 0.7 second. The rest of the ranges have a bandwidth of 10 Hz and response time of 70 ms.

7 With the meter in the probe type A position, the dc amplifier provides a voltage gain of 15 and is controlled by the Cal Factor attenuator. A capacitor filters out noise and provides a sharper bandwidth on the three lower ranges. Feedback through the attenuator changes the gain of the amplifier in 2% steps to compensate for the calibration factor of the detector. The low impedance output drives the meter, recorder output, and the servo amplifier.

8 The servo amplifier is used with the Cal Hold and Zero Hold circuits to calibrate or zero the Radiant Flux Meter. In the CAL mode the gain of the instrument is adjusted to calibrate on the 3 mW/cm^2 range. In the ZERO mode an offset voltage is established to zero the instrument on the range in use. The output of the dc amplifier is compared with a regulated reference voltage from the power supply. Any difference voltage is amplified and used as an error voltage to drive the Cal or Zero Hold circuits. Gain of this circuit is determined by the signal through the feedback circuit. In the CAL mode, the reference voltage is +1 volt and the gain of the servoamplifier is 15,000. In the ZERO mode, the reference voltage is 0 volt and the gain of the amplifier is 750.

9 When the MODE switch is placed in the CAL position, the .395 mW 10 kHz calibration signal is applied to the Detector and the relay to the Cal Hold circuit is activated. At the thermopile, a dc voltage proportional to the calibration signal is generated. This dc voltage is converted to ac, amplified and synchronously detected. The voltage from the dc amplifier is applied to the input of the servo amplifier. This input voltage is compared to a +1 volt reference applied to the servo amplifier. Any difference is amplified and applied as an error voltage to the Cal Hold circuit. The Cal Hold circuit controls the resistance of the Variable Resistance FET; when the resistance changes, the gain of the variable gain amplifier changes. The gain is adjusted until the output of the dc amplifier matches the reference voltage applied to the servo amplifier. When this happens, the Model 8330A is calibrated to the Detector on the 3 mW/cm^2 range.

10 In the ZERO mode, the servo amplifier drives the Zero Hold Circuit. This circuit maintains an offset voltage at the input of the Model 8330A to zero the instrument on the range in use. If the output of the dc amplifier does not match the zero

(0) reference to the servo amplifier, the difference is amplified and used as an error voltage to drive the Zero Hold circuit. This circuit changes the offset at the input until the dc amplifier output matches the reference voltage. When this happens, the instrument is zeroed on the range in use.

11 The 107 Hz multivibrator, with Class B complimentary symmetry outputs, provides current driving capabilities necessary to operate the chopper and the signal requirements necessary to operate the synchronous demodulator.

12 The calibration oscillator provides a 10 kHz signal that is precisely .395 mW in amplitude to the thermopile during the CAL mode of operation. The output impedance of the oscillator is 474 ohms which is used for power match with the thermopile detector. This match compensates for possible ±20% variations in resistance. When the oscillator signal is applied to the thermopile, a dc voltage proportional to the .395 mW signal is generated. The voltage is converted to ac, amplified, detected, dc amplified, and compared to the reference voltage at the servo amplifier. The gain of the variable gain amplifier is changed until the instrument is calibrated to 3 mW/cm^2. A portion of the oscillator signal is coupled back to the peak detector and comparator. This stage controls the output amplitude of the oscillator by varying the Q of the oscillator tank. If the oscillator signal is above .395 mW, the comparator reduces it to the correct level by lowering the Q of the oscillator tank. If the output is below .395 mW, the comparator raises the Q of the tank, which raises the amplitude of the oscillator signal.

13 The +16 volt regulator consists of a reference diode, sensing amplifier, control amplifier, and series regulator. The sensing amplifier compares the series regulator output with the reference diode. Any difference is amplified and used to drive the control amplifier. The control amplifier determines the drive to the series regulator, thus controlling the output voltage from the series regulator.

14 The –16 volt regulator, which consists of the sensing amplifier, control amplifier, and series regulator, is referenced to the +16V supply. Any difference voltage at the comparison point is amplified by the sensing amplifier and coupled to the control amplifier. This amplifier determines the output of the series regulator. Current limiting protects both the negative and positive supplies from overloads.

15 The decoupling networks provide various filtered positive and negative dc voltage to the Model 8330A circuits.

16 The relay driver provides control of the reed relays in the Zero/Cal circuit. These relays are activated in the ZERO and CAL modes of operation.

TABLE 1A. OVERALL TROUBLESHOOTING

CONDITIONS:

a. Connect 11594A to Model 8330A.

b. Set:

Model 8330A

CAL FACTOR %. . . 100%, 80—100% Range
MODE . . . . . OPERATE
RANGE . . . . . 100 mW/cm^2

11594A

RANGE . . . . . 30 mW/cm^2

c. Model 8330A should read at least 20% of meter range.

PROBLEM:

Model 8330A meter less than 20% of range.

MEASUREMENT CONDITIONS:

a. Waveforms

Model 8330A

CAL FACTOR % . . 100%, 80—100% Range
MODE . . . . . OPERATE
RANGE . . . . . 100 mW/cm^2

11594A

RANGE . . . . . 100 mW/cm^2

b. Voltage

Model 8330A

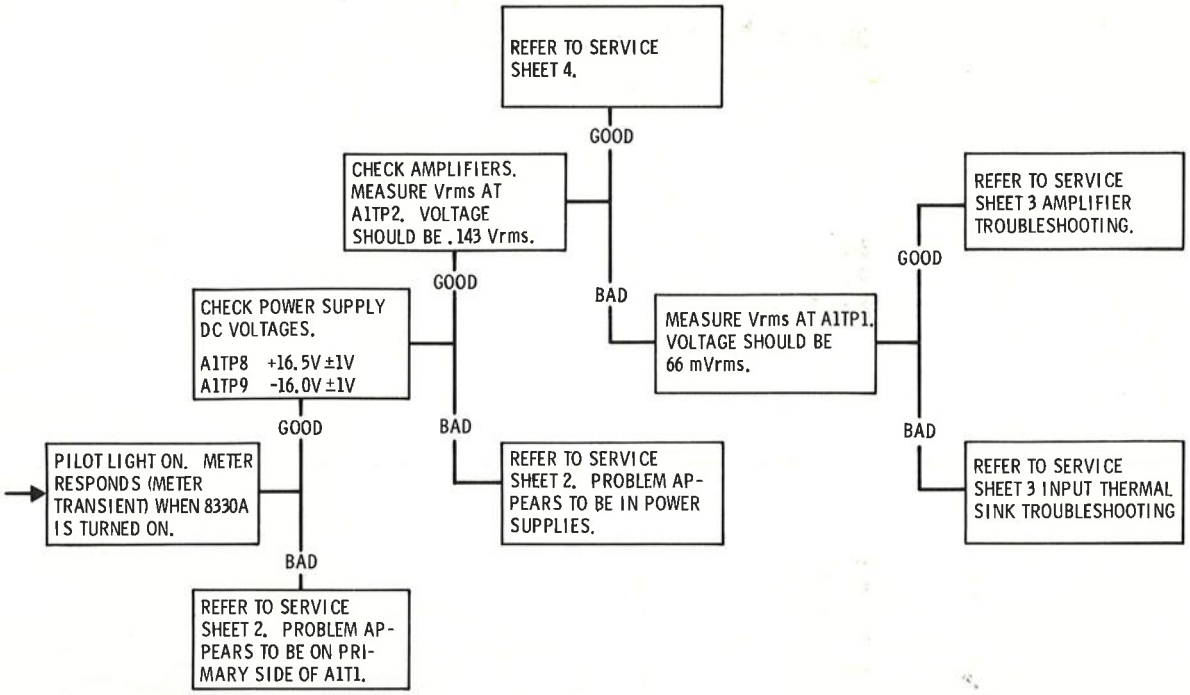
CAL FACTOR %. . . 100%, 80—100% Range
MODE . . . . . OPERATE
RANGE . . . . . 100 mW/cm^2

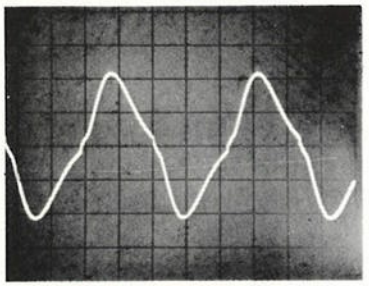
11594A

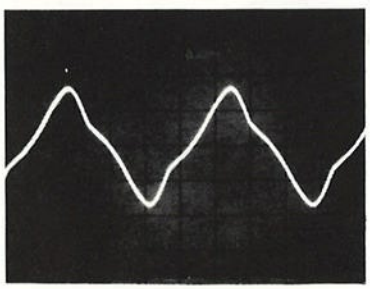
RANGE . . . . . OFF

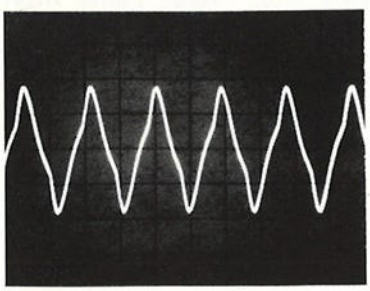
All measurements made with respect to the chassis.

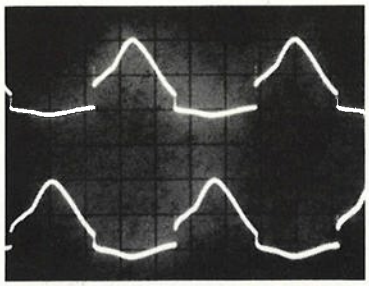
Figure

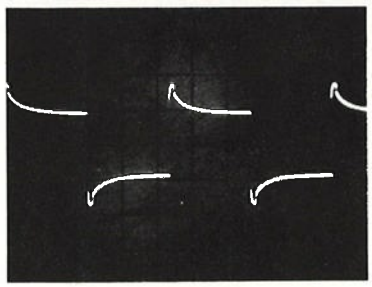

REFER TO SERVICE SHEET 4.
GOOD
CHECK AMPLIFIERS. MEASURE Vrms AT A1TP2. VOLTAGE SHOULD BE .143 Vrms.
GOOD
BAD
CHECK POWER SUPPLY DC VOLTAGES.
A1TP8 +16.5V ±1V
A1TP9 -16.0V ±1V
GOOD
BAD
PILOT LIGHT ON. METER RESPONDS (METER TRANSIENT) WHEN 8330A IS TURNED ON.
GOOD
BAD
REFER TO SERVICE SHEET 2. PROBLEM APPEARS TO BE ON PRIMARY SIDE OF A1T1.
REFER TO SERVICE SHEET 2. PROBLEM APPEARS TO BE IN POWER SUPPLIES.
MEASURE Vrms AT A1TP1. VOLTAGE SHOULD BE 66 mVrms.
GOOD
BAD
REFER TO SERVICE SHEET 3 AMPLIFIER TROUBLESHOOTING.
REFER TO SERVICE SHEET 3 INPUT THERMAL SINK TROUBLESHOOTING

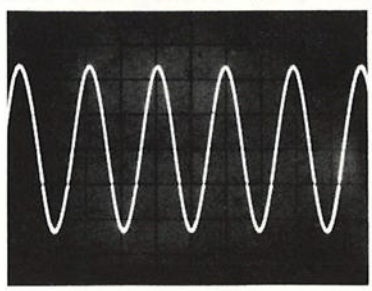












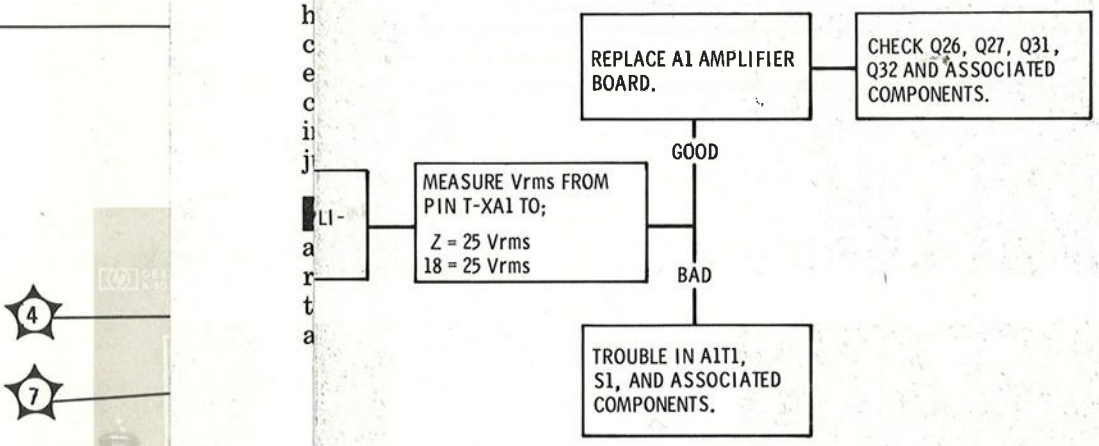
TEST POINT VOLTAGES (Vdc)

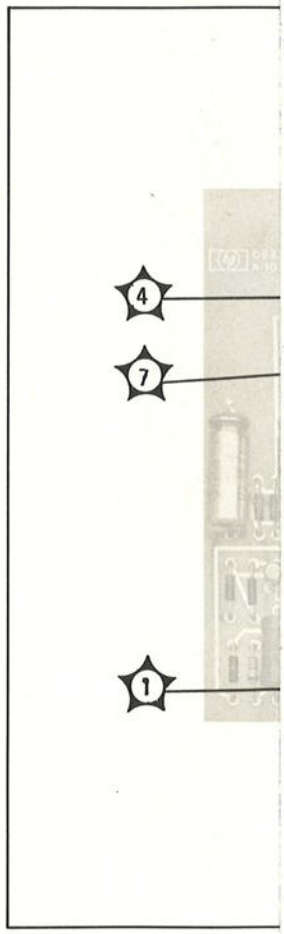
A1TP3 – 1.632V A1TP7 – 0 Volt A1TP8 – 16.5V A1TP9 – 16.0V A1TP11 – 13.34V

TEST POINT INFORMATION

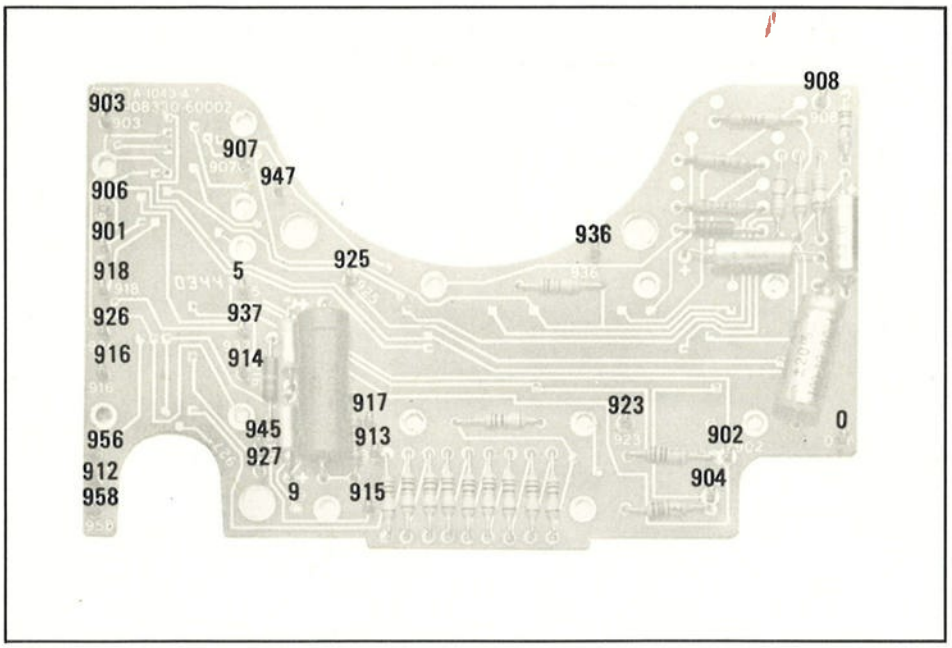
SER SUPPLY TROUBLESHOOTING

Range
RATE
W/cm²

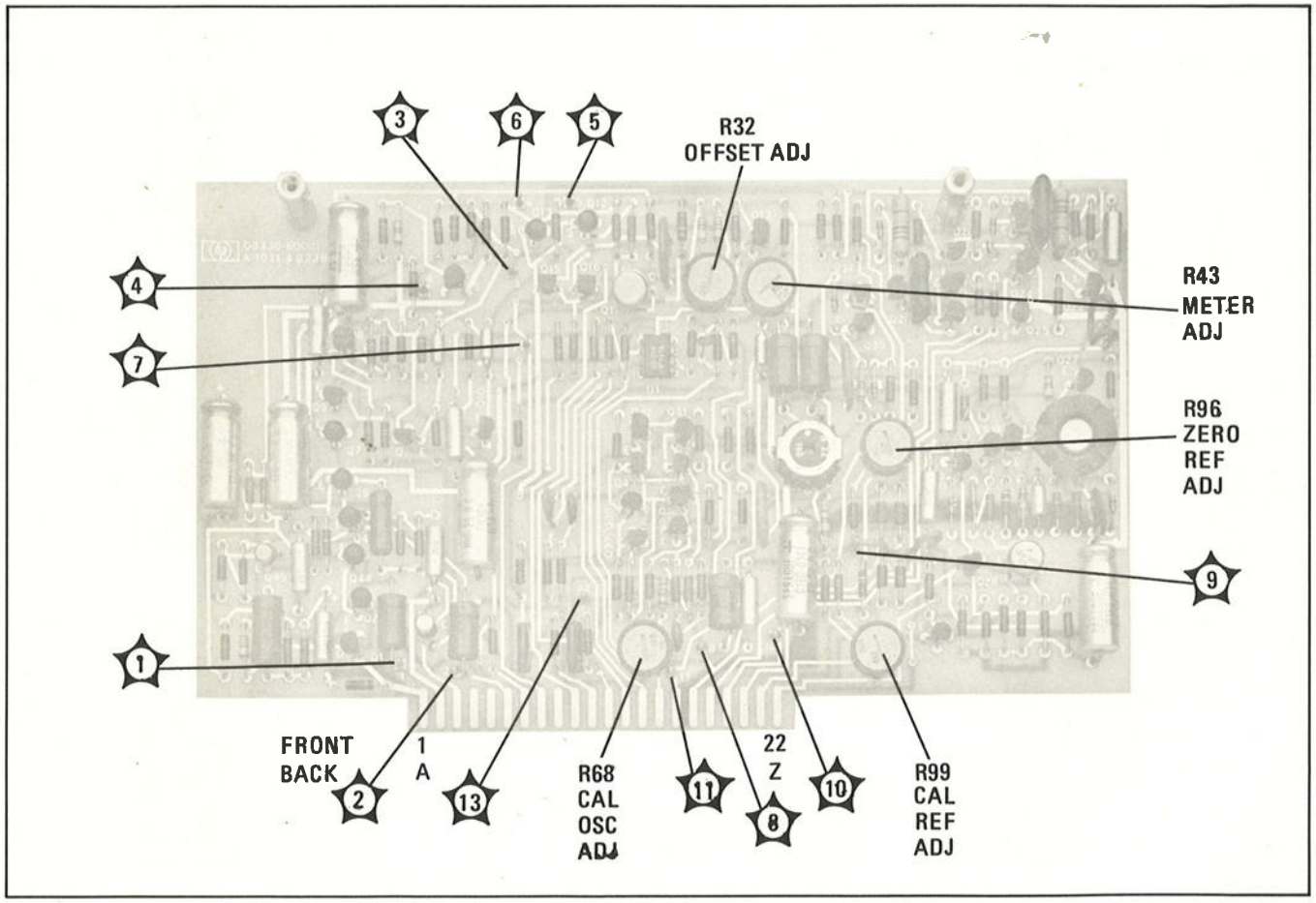

REPLACE A1 AMPLIFIER BOARD.
CHECK Q26, Q27, Q31, Q32 AND ASSOCIATED COMPONENTS.
GOOD
MEASURE Vrms FROM PIN T-XA1 TO;
Z = 25 Vrms
18 = 25 Vrms
BAD
TROUBLE IN A1T1, S1, AND ASSOCIATED COMPONENTS.



SERVICE SHEET 1
Servicing Block Diagram



A2 Switching Assembly



A1 Amplifier Assembly

Figure 1A. Test Point Locations

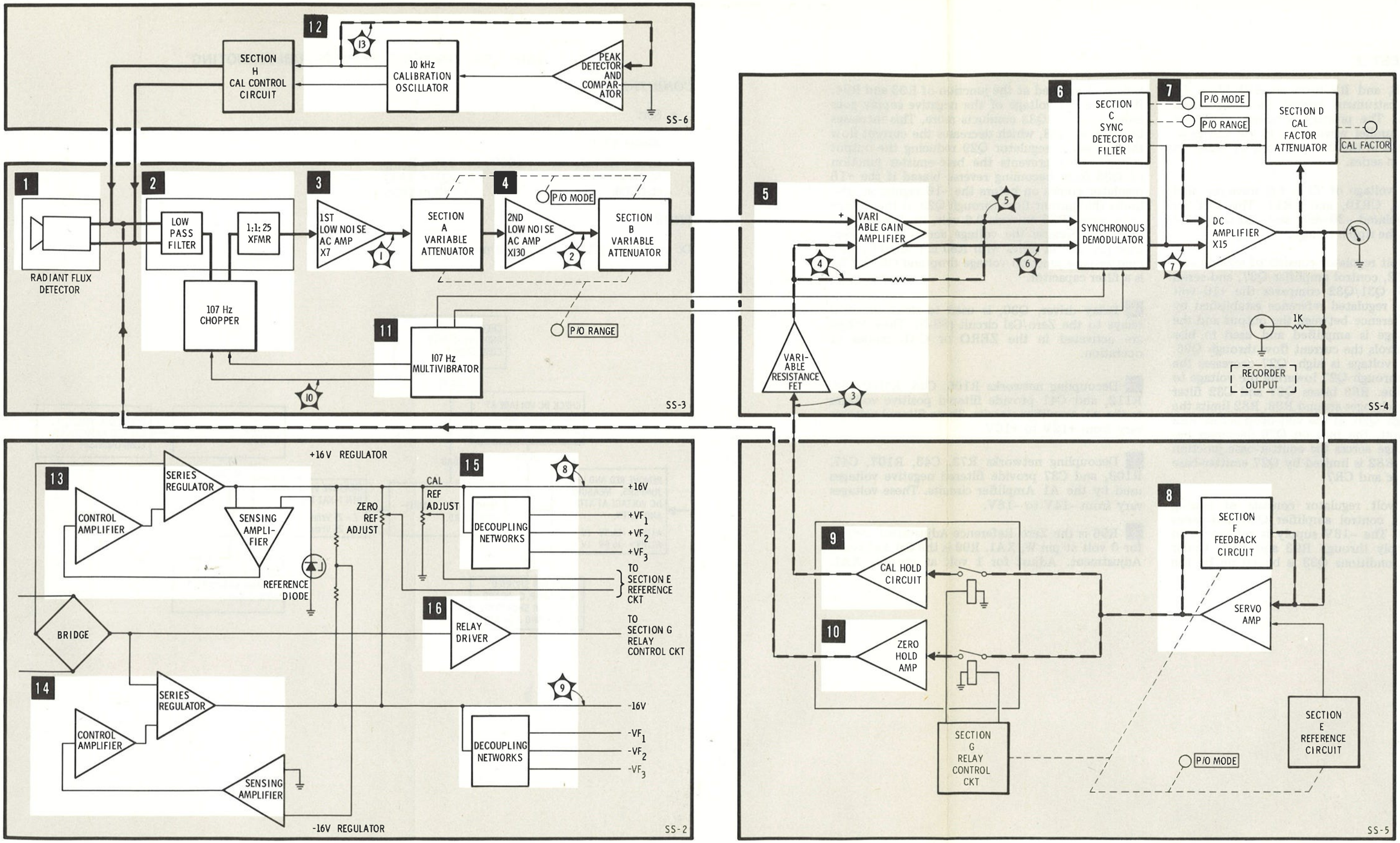


Figure 1B. Servicing Block Diagram

SERVICE SHEET 2

1 R1, C1A/B, and R2 form an RFI filter. F1 protects the instrument against line surges and internal shorts. The primary windings of T1 are connected in parallel when S2 is in the 115 position. When S2 is in the 230 position, T1 windings are connected in series.

2 Secondary voltage of T1 is full-wave rectified by CR8, CR9, CR10, and CR11. This rectifier provides unregulated –30 volts and +30 volts. C30 and C31 filter the ripple voltage.

3 The +16 volt regulator consists of sensing amplifier Q31/Q32, control amplifier Q27, and series regulator Q26. Q31/Q32 compares the +16 volt output with a regulated reference established by CR5. Any difference between the output and the reference voltage is amplified and used to bias Q27; Q27 controls the current flow through Q26. If the output voltage is high, Q27 decreases the current flow through Q27 lowering the voltage to its correct value. R83 biases Q27 and C32 filter high frequency changes around R83. R82 limits the current through Q26. If the volt-drop across R82 exceeds 0.6 volt, the bias on Q26 decreases because the voltage across the emitter-base junction in series with R82 is limited by Q27 emitter-base junction voltage and CR7.

4 The –16 volt regulator consists of sensing amplifier Q33, control amplifier Q28 and series regulator Q29. The –16V supply is referenced to the +16V supply through R93 and R94. Under all operating conditions Q33 is biased on by the voltage developed at the junction of R93 and R94. If the output voltage of the negative supply goes more negative, Q33 conducts more. This increases the bias on Q28, which decreases the current flow through series regulator Q29 reducing the output voltage. CR6 prevents the base-emitter junction of Q33 from becoming reverse biased if the +16 regulator comes on before the –16 regulator. R85 limits the current flow through Q29. If the voltage drop across R85 exceeds 0.6 volt, the bias on Q29 decreases because the voltage across its emitter-base junction in series with R85 is limited by Q28 emitter-base junction voltage drop and CR12. C34 is a filter capacitor.

5 Relay driver, Q30, is used to drive the reed relays to the Zero/Cal circuit (SS-5). These relays are activated in the ZERO or CAL modes of operation.

6 Decoupling networks R106, C46, R108, C38, R112, and C41 provide filtered positive voltages to the A1 Amplifier circuits. These filtered voltages vary from +12V to +16V.

7 Decoupling networks R73, C43, R107, C47, R109, and C37 provide filtered negative voltages used by the A1 Amplifier circuits. These voltages vary from -14V to -16V.

8 R96 is the Zero Reference Adjustment. Adjust for 0 volt at pin W, XA1. R99 is the Cal Reference Adjustment. Adjust for 1 volt at pin 21, XA1.

TABLE 2A. POWER SUPPLY TROUBLESHOOTING

CONDITIONS:

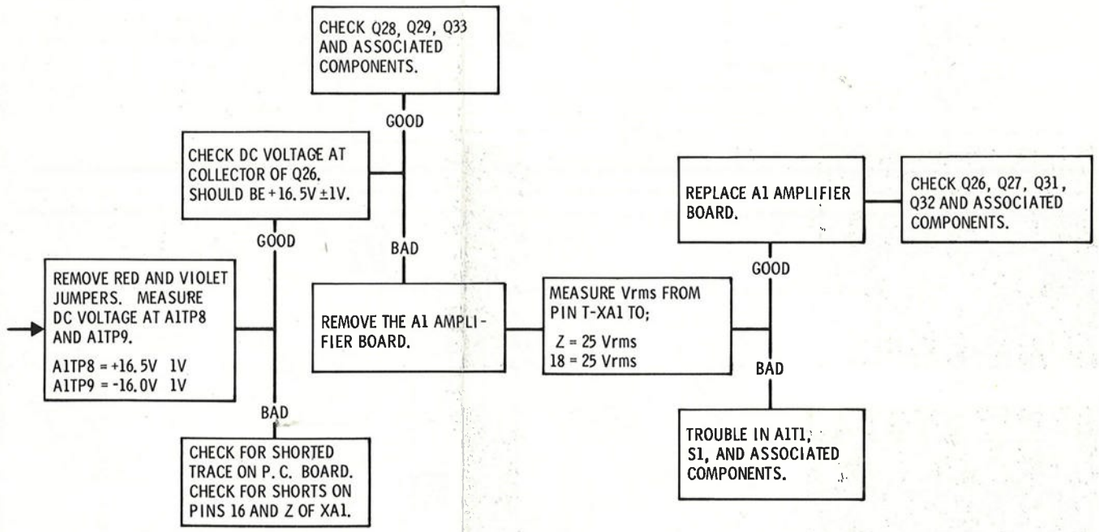
a. Set:

Model 8330A

CAL FACTOR %. . . 100%, 30—100% Range
MODE . . . . . OPERATE
RANGE . . . . . 100 mW/cm^2

PROBLEM:

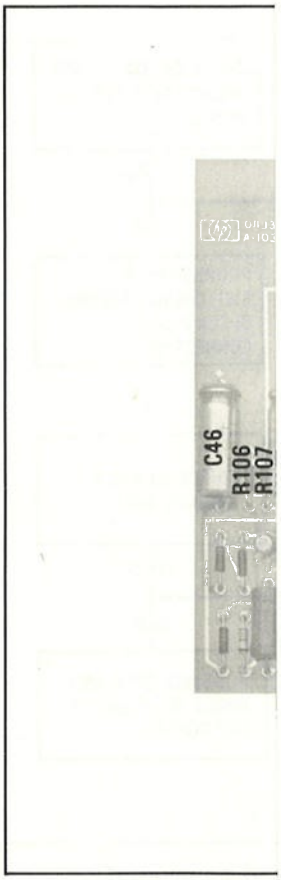
Dc voltage at A1TP8 or A1TP9 not correct.


CHECK Q28, Q29, Q33 AND ASSOCIATED COMPONENTS.
GOOD
CHECK DC VOLTAGE AT COLLECTOR OF Q26. SHOULD BE +16.5V ±1V.
GOOD
BAD
REMOVE RED AND VIOLET JUMPERS. MEASURE DC VOLTAGE AT A1TP8 AND A1TP9.
A1TP8 = +16.5V 1V
A1TP9 = -16.0V 1V
BAD
CHECK FOR SHORTED TRACE ON P. C. BOARD. CHECK FOR SHORTS ON PINS 16 AND Z OF XA1.
REMOVE THE A1 AMPLIFIER BOARD.
MEASURE Vrms FROM PIN T-XA1 TO;
Z = 25 Vrms
18 = 25 Vrms
GOOD
BAD
TROUBLE IN A1T1, S1, AND ASSOCIATED COMPONENTS.
REPLACE A1 AMPLIFIER BOARD.
CHECK Q26, Q27, Q31, Q32 AND ASSOCIATED COMPONENTS.
GOOD

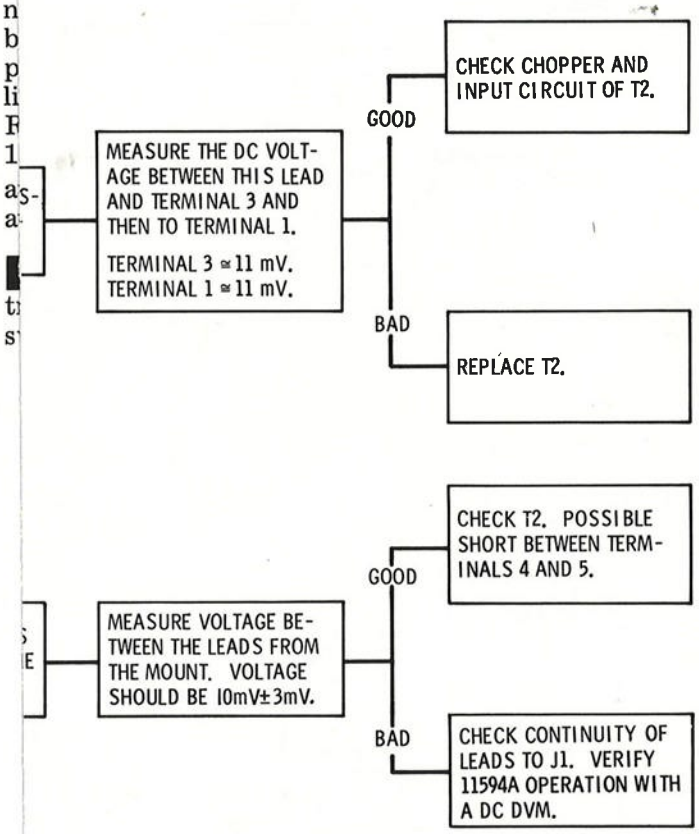
SERVICE SHEET 1
Servicing Block Diagram

S

SMAL SINK TROUBLESHOOTING



Figure


MEASURE THE DC VOLTAGE BETWEEN THIS LEAD AND TERMINAL 3 AND THEN TO TERMINAL 1.
TERMINAL 3 ≅ 11 mV.
TERMINAL 1 ≅ 11 mV.
GOOD
CHECK CHOPPER AND INPUT CIRCUIT OF T2.
BAD
REPLACE T2.
MEASURE VOLTAGE BETWEEN THE LEADS FROM THE MOUNT. VOLTAGE SHOULD BE 10mV±3mV.
GOOD
CHECK T2. POSSIBLE SHORT BETWEEN TERMINALS 4 AND 5.
BAD
CHECK CONTINUITY OF LEADS TO J1. VERIFY 11594A OPERATION WITH A DC DVM.

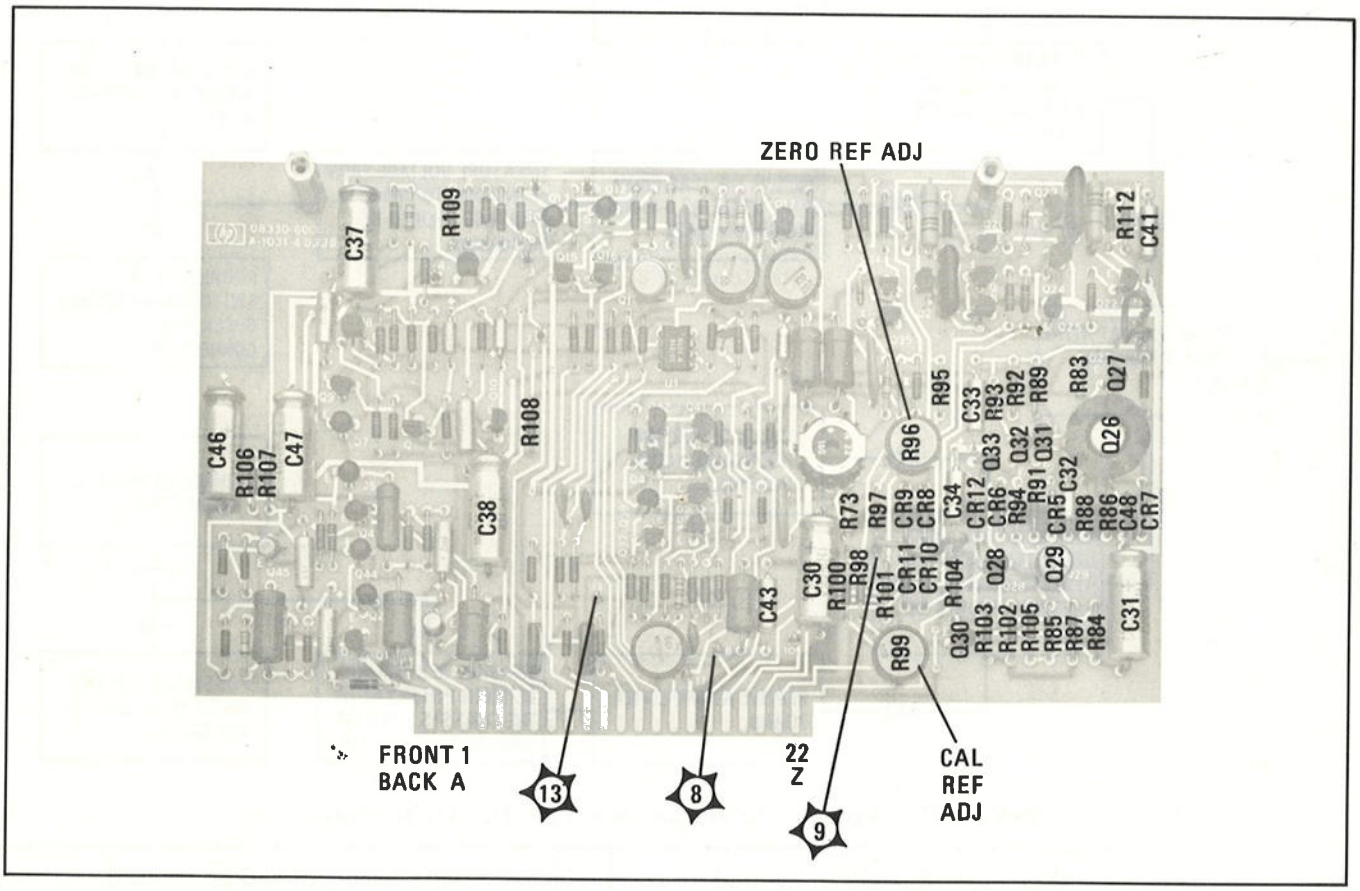
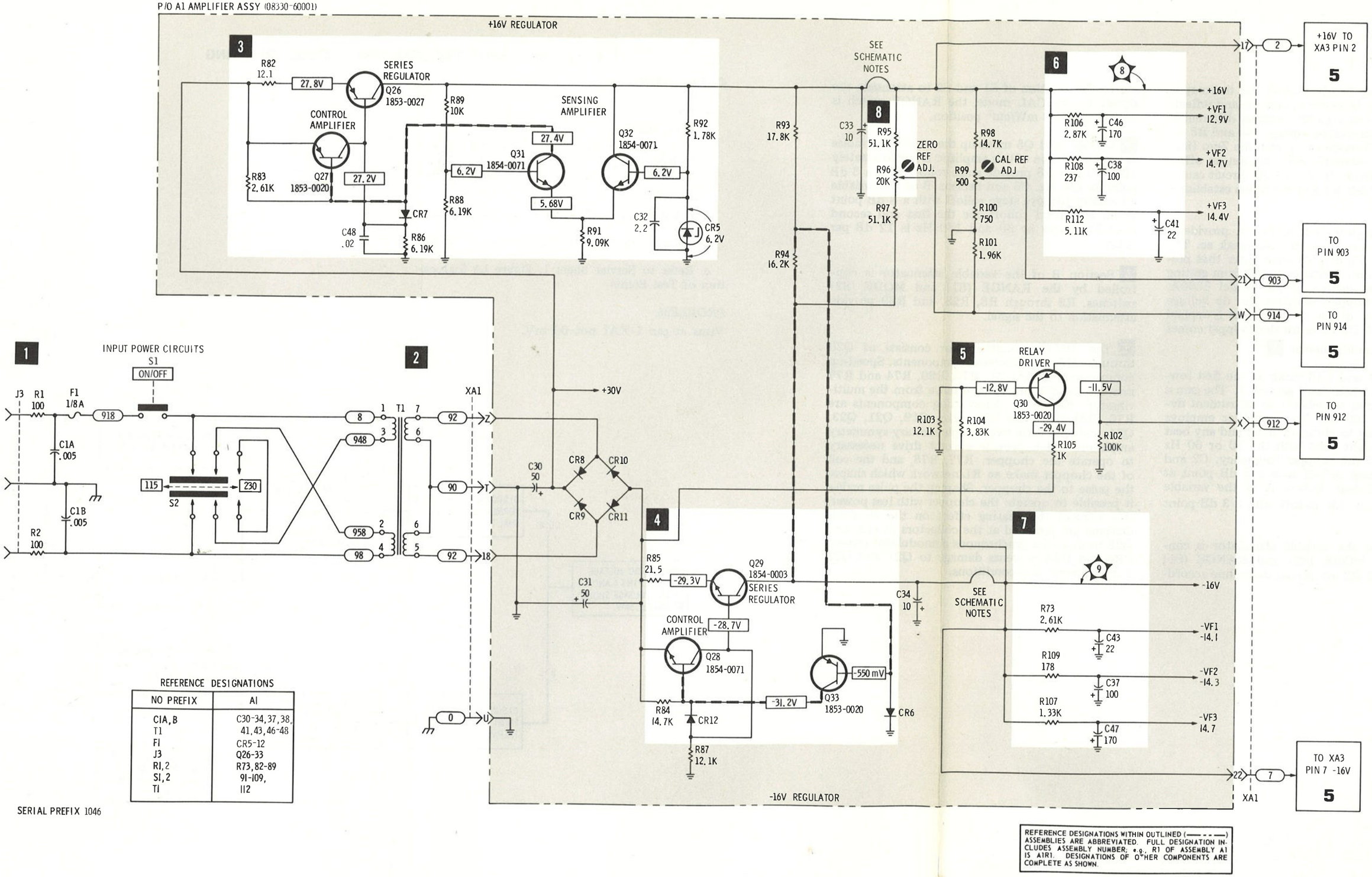


Figure 2A. A1 Amplifier Assembly Power Supply, Component Locations



REFERENCE DESIGNATIONS

NO PREFIX	A1
C1A,B	C30-34,37,38,
T1	41,43,46-48
F1	CR5-12
J3	Q26-33
R1,2	R73,82-89
S1,2	91-109,
T1	112

SERIAL PREFIX 1046

REFERENCE DESIGNATIONS WITHIN OUTLINED (— — —) ASSEMBLIES ARE ABBREVIATED. FULL DESIGNATION INCLUDES ASSEMBLY NUMBER; e.g., R1 OF ASSEMBLY A1 IS A1R1. DESIGNATIONS OF OTHER COMPONENTS ARE COMPLETE AS SHOWN.

2 *Figure 2B. Power Supply Schematic*

SERVICE SHEET 3

1 Radiant energy incident upon the thermopile is absorbed by the blackened junctions and reflected by the others causing a temperature differential and, thus, a thermoelectric voltage. R4 and R5 are used in the ZERO mode along with the Zero Hold circuit (SS-5) to establish and maintain an offset voltage. Voltage from the Zero Hold circuit causes current flow through R4 and R5 which establishes the offset voltage.

2 T2, a 1:1:25 step-up transformer, provides a step-up of 50 from dc to peak-to-peak ac. The input portion of T2 is a low-pass filter that prevents the calibration oscillator signal from getting into the amplifier section of the Model 8330A. G1, a 107 Hz chopper, converts the dc voltage from the Detector into an ac signal that is applied to the primary of T2. Drive for the chopper comes from the 110 Hz multivibrator **7**

3 Q1, Q2, Q44 and Q45 make up the first low-noise ac amplifier which has a gain of 7. The gain is purposely restricted to achieve an instrument dynamic range of 100 dB. This amplifier employs bandwidth shaping to eliminate noise and any beat problems that might exist with the 50 or 60 Hz line voltages and the chopper frequency. C2 and R4 produce a stage rolloff with a 3 dB point at 180 Hz and C3 and Section A of the variable attenuator **4** provide rolloff with a 3 dB point at 60 Hz.

4 Section A of the variable attenuator is controlled by the MODE (S2) and RANGE (S1) switches. R1 and R2 are placed in the line according to the position of S1 and S2 to attenuate the signal. In the CAL mode, the RANGE switch is placed in the 3 mW/cm^2 position.

5 Q3, Q4, and Q5 make up the second low-noise ac amplifier. Gain of this amplifier is approximately 130. C5 and R8 provide stage rolloff with a 3 dB point at 180 Hz. C6 and Section B of the variable attenuator (6) give stage rolloff with a 3 dB point at 60 Hz. Total rolloff for the first and second amplifier stages at 60 and 180 Hz is 12 dB per octave.

6 Section B of the variable attenuator is controlled by the RANGE (S1) and MODE (S2) switches. R3 through R8, R28, and R29 provide attenuation to the signal.

7 The 107 Hz multivibrator consists of Q20 through Q23 and associated components. Speed-up components, Q20, Q22, R75, R80, R74 and R79 increase the rise time of the pulse from the multivibrator. Frequency determining components are R76, R81, C27 and C29, Q18, Q19, Q21, Q23, Q24, and Q25 form two complementary symmetry amplifiers which provide current drive necessary to operate the chopper. R77, R78, and the coil of the chopper make an RL network which shapes the pulse to the chopper. Shaping the pulse makes it possible to operate the chopper with less power; this reduces the heating effect on the chopper. Outputs are provided at the collectors of Q20 and Q22 to drive the synchronous demodulator (SS-4). CR3 and CR4 prevents damage to Q21 and Q23 during reverse bias conditions.

TABLE 3A. INPUT THERMAL SINK TROUBLESHOOTING

CONDITIONS:

a. Set:

Model 8330A

CAL FACTOR %. . . 100%, 80—100% Range
MODE . . . . . OPERATE
RANGE . . . . . 100 mW/cm^2

11594A

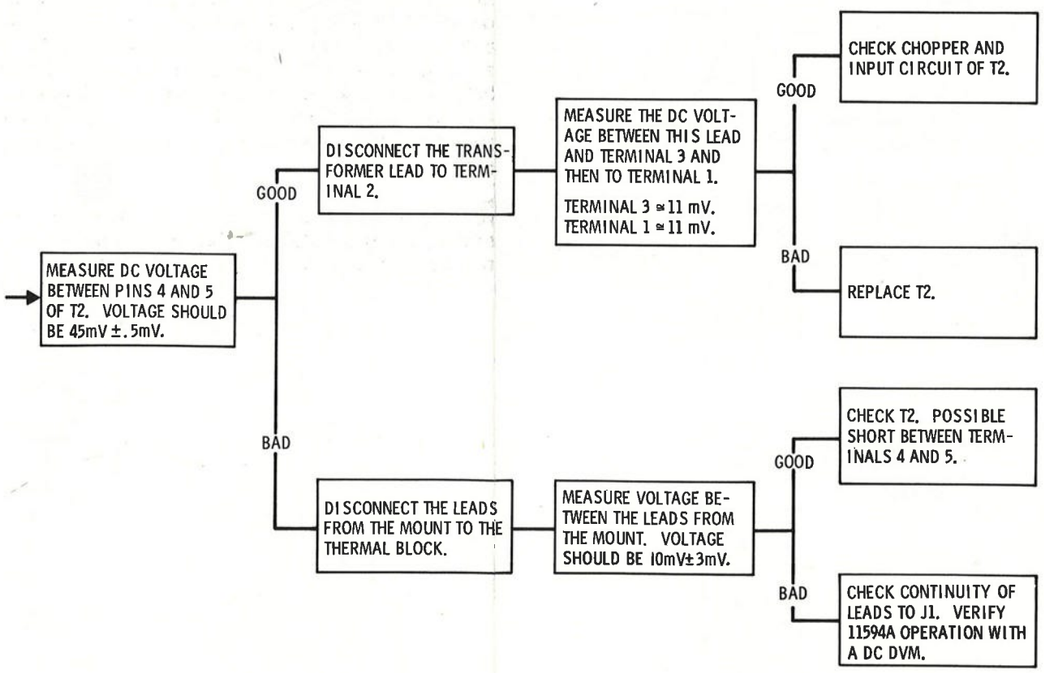
RANGE . . . . . 100 mW/cm^2

b. Use a floating DVM to measure the dc voltage.

c. Refer to Service Sheet 1, Figure 1A for location of Test Points.

PROBLEM:

Vrms at pin 1-XA1 not 66 mV.


MEASURE DC VOLTAGE BETWEEN PINS 4 AND 5 OF T2. VOLTAGE SHOULD BE 45mV ±.5mV.
GOOD
DISCONNECT THE TRANSFORMER LEAD TO TERMINAL 2.
MEASURE THE DC VOLTAGE BETWEEN THIS LEAD AND TERMINAL 3 AND THEN TO TERMINAL 1.
TERMINAL 3 ≈ 11 mV.
TERMINAL 1 ≈ 11 mV.
GOOD
CHECK CHOPPER AND INPUT CIRCUIT OF T2.
BAD
REPLACE T2.
BAD
DISCONNECT THE LEADS FROM THE MOUNT TO THE THERMAL BLOCK.
MEASURE VOLTAGE BETWEEN THE LEADS FROM THE MOUNT. VOLTAGE SHOULD BE 10mV±3mV.
GOOD
CHECK T2. POSSIBLE SHORT BETWEEN TERMINALS 4 AND 5.
BAD
CHECK CONTINUITY OF LEADS TO J1. VERIFY 11594A OPERATION WITH A DC DVM.

SERVICE SHEET 2
Power Supply Circuits

TABLE 3B. AC AMPLIFIER TROUBLESHOOTING

CONDITIONS:

a. Set:

Model 8330A

CAL FACTOR %. . . 100%, 80—100% Range
MODE . . . . . OPERATE
RANGE . . . . . 100 mW/cm^2

11594A

RANGE . . . . . 100 mW/cm^2

b. Voltage between pins 1 and A-XA1 good.

PROBLEM:

Vrms at A1TP2 not .37V

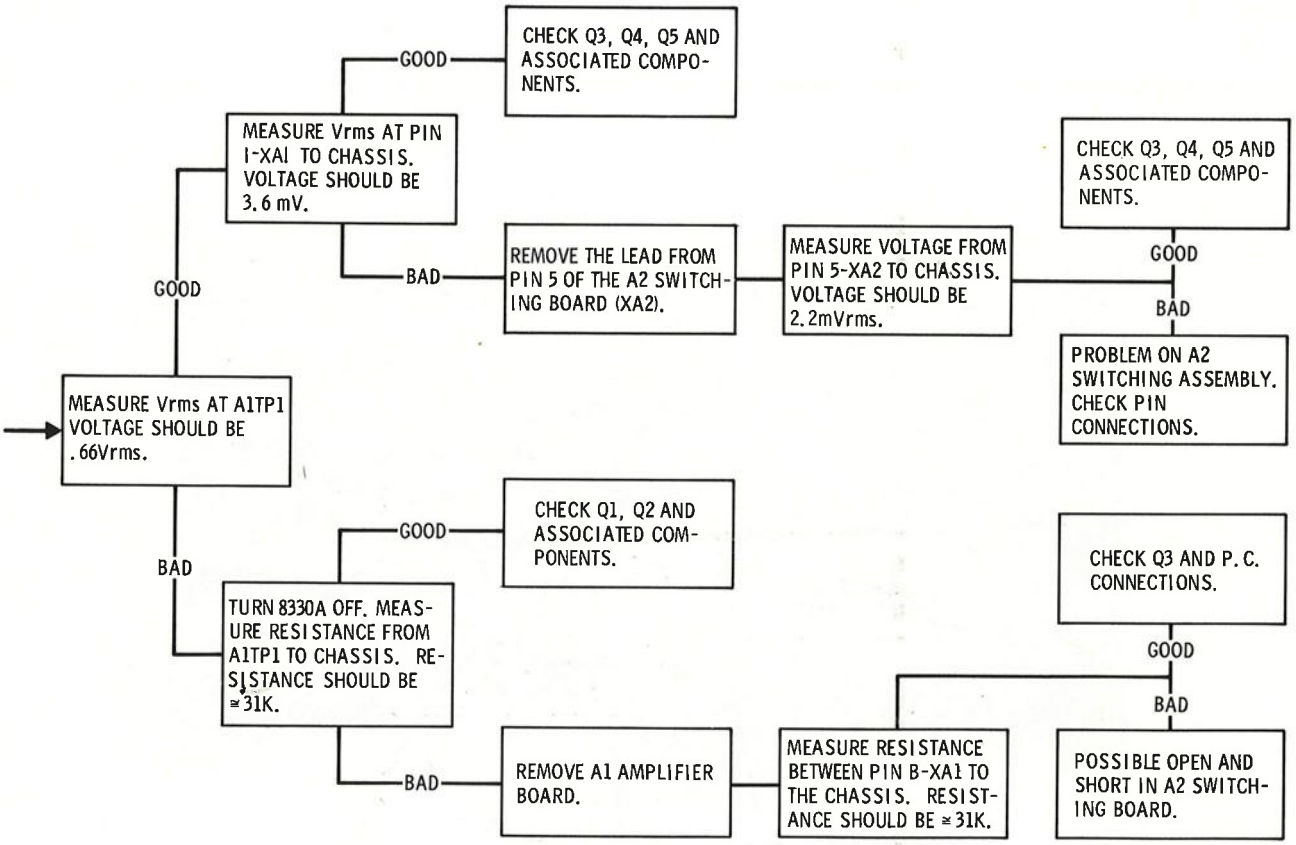
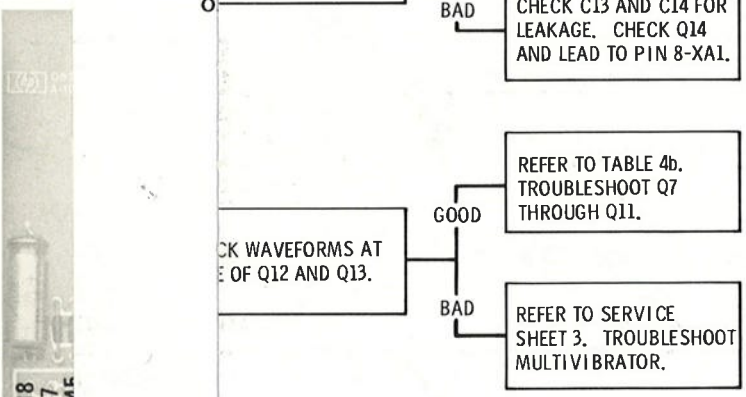

MEASURE Vrms AT A1TP1 VOLTAGE SHOULD BE .66Vrms.
GOOD
MEASURE Vrms AT PIN 1-XA1 TO CHASSIS. VOLTAGE SHOULD BE 3.6 mV.
GOOD
CHECK Q3, Q4, Q5 AND ASSOCIATED COMPONENTS.
BAD
REMOVE THE LEAD FROM PIN 5 OF THE A2 SWITCHING BOARD (XA2).
MEASURE VOLTAGE FROM PIN 5-XA2 TO CHASSIS. VOLTAGE SHOULD BE 2.2mVrms.
CHECK Q3, Q4, Q5 AND ASSOCIATED COMPONENTS.
GOOD
BAD
PROBLEM ON A2 SWITCHING ASSEMBLY. CHECK PIN CONNECTIONS.
BAD
TURN 8330A OFF. MEASURE RESISTANCE FROM A1TP1 TO CHASSIS. RESISTANCE SHOULD BE ≅ 31K.
GOOD
CHECK Q1, Q2 AND ASSOCIATED COMPONENTS.
BAD
REMOVE A1 AMPLIFIER BOARD.
MEASURE RESISTANCE BETWEEN PIN B-XA1 TO THE CHASSIS. RESISTANCE SHOULD BE ≅ 31K.
CHECK Q3 AND P.C. CONNECTIONS.
GOOD
BAD
POSSIBLE OPEN AND SHORT IN A2 SWITCHING BOARD.

Table 3C. Voltage Table for the 107 Hz Multivibrator

	Q21 base shorted to ground			Q23 base shorted to ground		
	E	B	C	E	B	C
Q18	14	14.7V	28V	0.79V	81 mV	28V
Q19	14V	14.7V	0V	0.79V	81 mV	0V
Q20	14.7V	14.7V	14V	28V	14.6V	88 mV
Q21	0V	0V	14.7V	0V	0.6V	88 mV
Q22	14.7V	14.6V	81 mV	28V	14V	24.6V
Q23	0V	0.6V	81 mV	0V	0V	14.6V
Q24	0.79V	81 mV	28V	14V	14.6V	28V
Q25	0.79V	81 mV	0V	14V	14.6V	0V

SE SPLITTER AMPLIFIER, SYNCHRONOUS MPLIFIER TROUBLESHOOTING


SURE DC VOLTAGE
ITP7. VOLTAGE
ULD BE 70 mV.
GOOD
BAD
CHECK Q14-Q17 AND ASSOCIATED COMPONENTS.
CHECK C13 AND C14 FOR LEAKAGE. CHECK Q14 AND LEAD TO PIN 8-XA1.
CK WAVEFORMS AT
E OF Q12 AND Q13.
GOOD
BAD
REFER TO TABLE 4b. TROUBLESHOOT Q7 THROUGH Q11.
REFER TO SERVICE SHEET 3. TROUBLESHOOT MULTIVIBRATOR.

SERVICE SHEET 3
Input Circuits

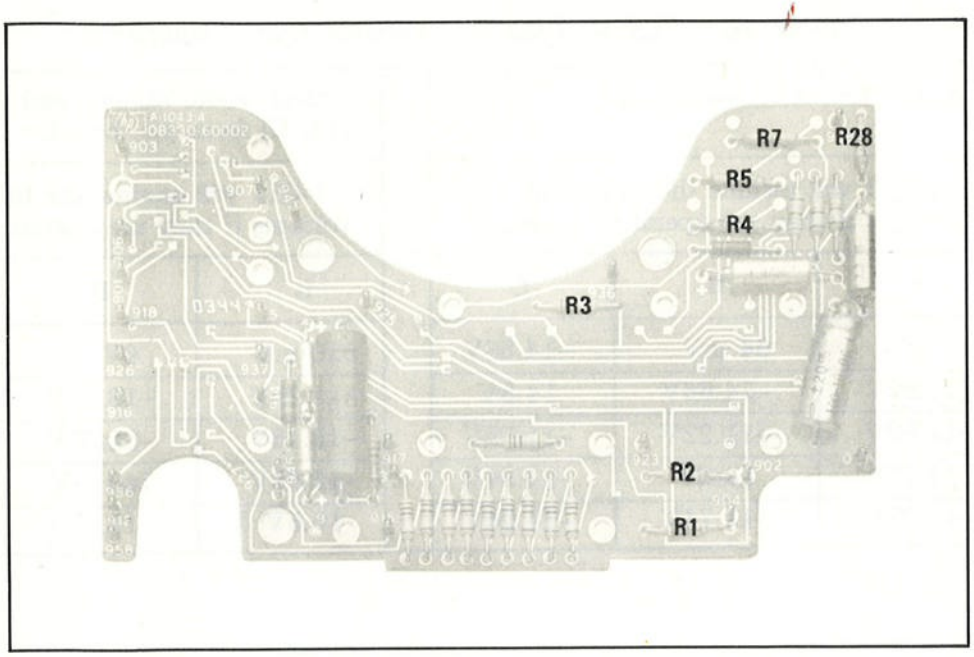


Figure 3A. A2 Switching Assembly Component Locations

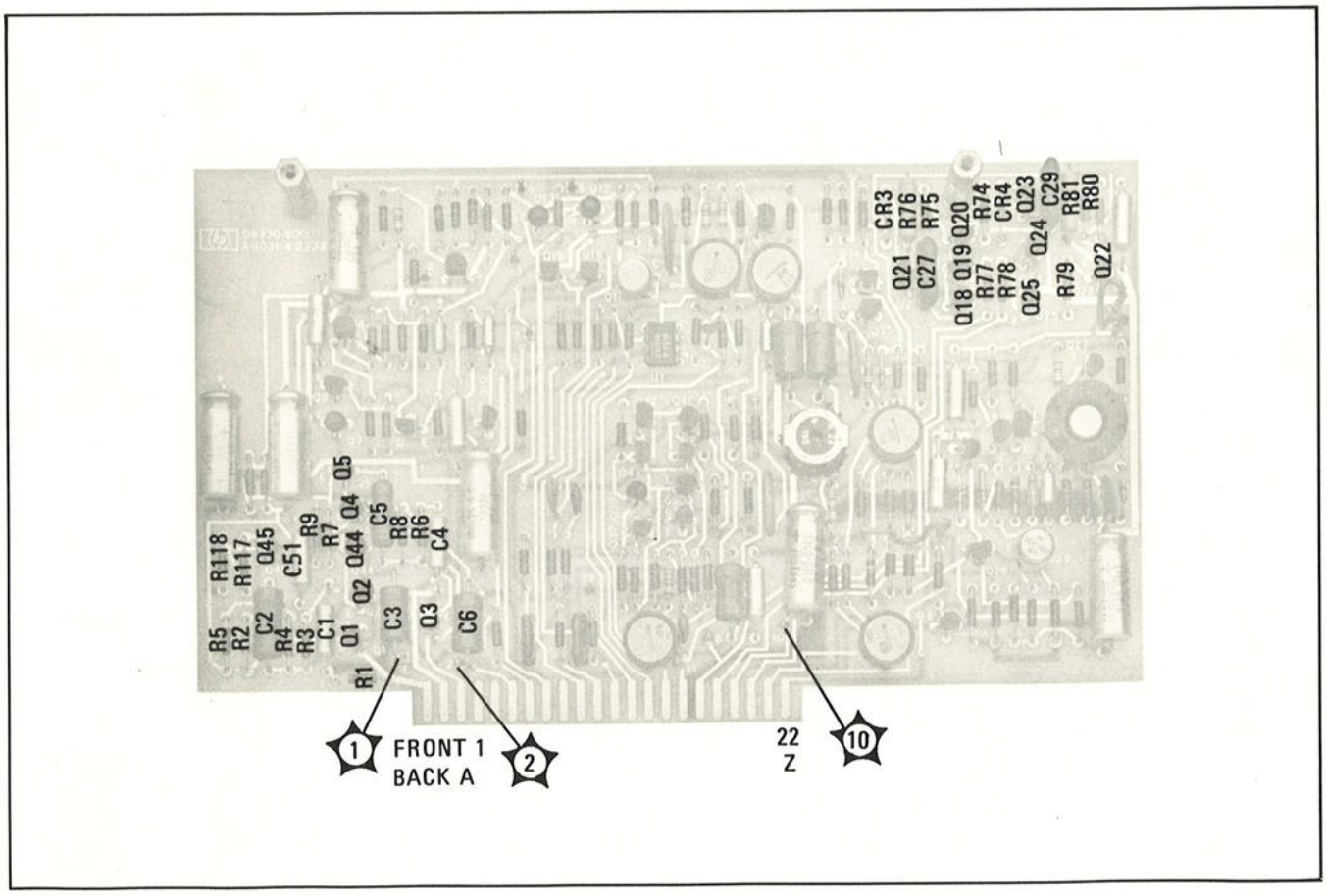
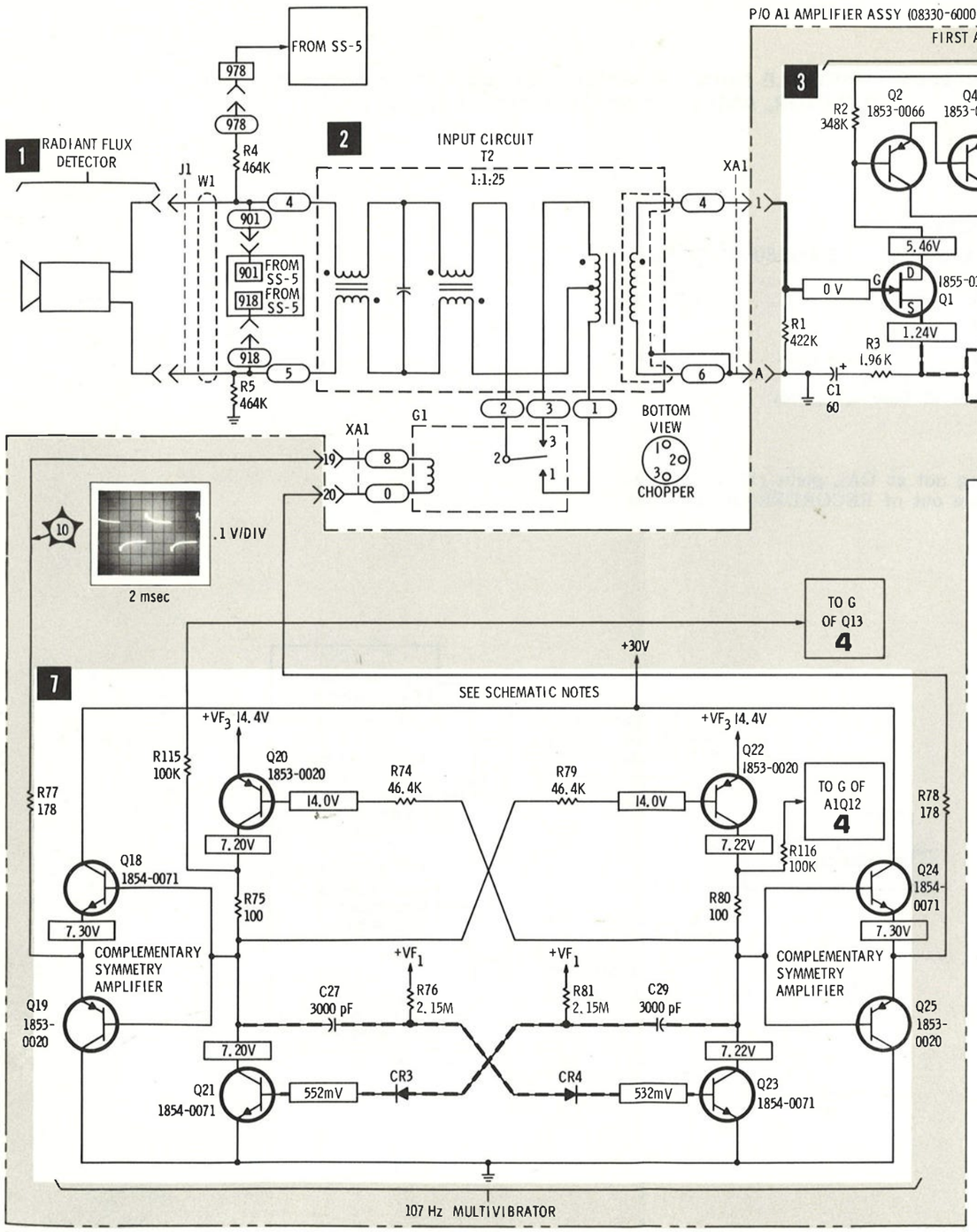


Figure 3B. A1 Amplifier Assembly Component Locations



REFERENCE DESIGNATIONS

NO PREFIX	A1	A2
G1	C1-6,27,29,	R1-5,7,
J1	51	28
R4	CR3,4	P.O S1,2
R5	Q1-5,18-25	
T2	,44,45	
W1,2	R1-9,74-81,	
	115-118	

REFERENCE DESIGNATIONS WITHIN OUTLINED (— · — ·) ASSEMBLIES ARE ABBREVIATED. FULL DESIGNATION INCLUDES ASSEMBLY NUMBER; e.g., R1 OF ASSEMBLY A1 IS A1R1. DESIGNATIONS OF OTHER COMPONENTS ARE COMPLETE AS SHOWN.

NOTES:

1. ALL DC MEASUREMENTS OF THE MULTIVIBRATOR MADE IN THE PRESENCE OF HIGH AC.

SERIAL PREFIX 1046

3 *Figure 3C. Input Circuit Schematic*

SERVICE SHEET 4

1 Q6 is a variable resistance **FET used** to change the gain of the Variable Gain amplifier in the CAL mode of operation. The resistance of Q6 and feedback resistor R22 set the gain. The resistance of Q6 is changed by the voltage from the Cal Hold circuit (SS-5).

2 Q7, Q8, Q9, Q10, and Q11 make up the variable gain amplifier. This circuit provides two signals equal in amplitude and 180° out of phase. C13 and C14 couple these signals to the synchronous detector. Q7 amplifies the signal from the second variable attenuator. Q8 and Q9 provide two signals to drive Q10 and Q11. The output of Q10 and Q11 drives the synchronous detector.

3 Synchronous Detector, Q12 and Q13, is driven by the 107 Hz multivibrator. This stage changes the ac signal from the Variable Gain amplifier to a dc voltage. When Q12 is turned on by the 107 Hz signal, Q13 is turned off. The signal through C13 is shunted to ground through Q12. The signal through C14 is coupled to the base of Q14A. Q12 turns off and Q13 turns on. The signal through C13 is now coupled to the base of Q14A.

4 C1, C2, and C3 along with A1R28 and A1R30 filter the voltage at the base of A1Q14A. The RC time constant of these components vary the bandwidth response of the synchronous detector. C1 and either A1R28 or A1R30 provide a bandwidth of 0.3 Hz and response time of 2.7 seconds. C2 and one of the A1 resistors provides a bandwidth of 1.5 Hz and a response time of 0.7 seconds. C3 and one of the A1 resistors provides a bandwidth of 10 Hz and a response time of 70 ms. R9, R10, and R11 provide a discharge path for C1, C2, and C3 when the MODE and RANGE positions are changed.

5 Q14A and B, Q15, Q16, and Q17 make up the dc amplifier. Q14 is a dual transistor selected for low drift. R32 controls the offset of Q14 so the meter can be zeroed properly. R35 matches the leakage current of Q14B with that of Q14A to reduce drift. Q15 and Q16 are matched for low drift and are used to drive Q17. R113 protects the meter from damage if Q17 shorts. The ratio of R40 to the Cal Factor resistive string controls the gain of the dc amplifier. The output of Q17 drives the recorder output, servo amplifier and meter.

6 R13 through R23 provide for 2% changes in the gain of the dc amplifier. In the lower two ranges, A1C50 is added to the feedback loop to minimize circuit noise. This capacitor prevents high-frequency changes at A1Q14A from affecting the meter.

7 R39 is an impedance matching resistor for the RECORDER OUTPUT. R43 adjusts the meter to full-scale with 1 volt at the RECORDER OUTPUT. R42 and RT1 compensate for changes in the temperature coefficient of the meter.

TABLE 4A. VARIABLE GAIN PHASE SPLITTER AMPLIFIER, SYNCHRONOUS DETECTOR, AND DC AMPLIFIER TROUBLESHOOTING

CONDITIONS:

a. Set:

Model 8330A

CAL FACTOR %. . . 100%, 80—100% Range
MODE . . . . . OPERATE
RANGE . . . . . 100 mW/cm^2

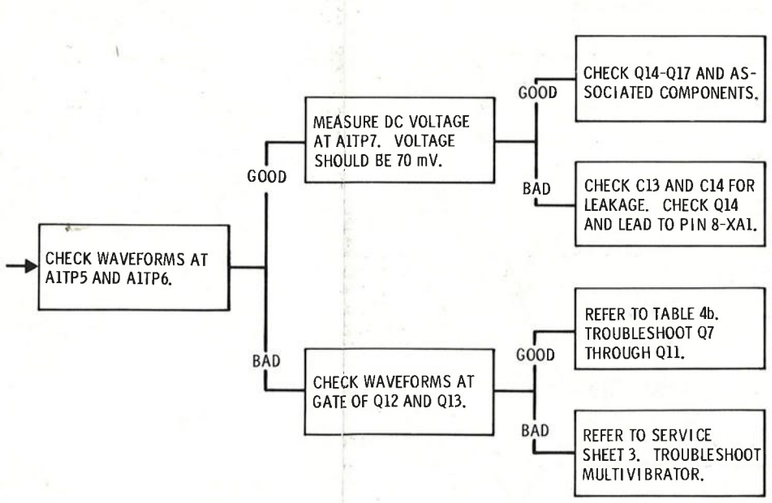
11594A

RANGE . . . . . 100 mW/cm^2

b. Waveform at base Q7 good.

PROBLEM:

Meter reading not at CAL point (±0.3% of full-scale). Voltage out of RECORDER OUTPUT not 1.0V ±.3V.


CHECK WAVEFORMS AT A1TP5 AND A1TP6.
GOOD
MEASURE DC VOLTAGE AT A1TP7. VOLTAGE SHOULD BE 70 mV.
GOOD
CHECK Q14-Q17 AND ASSOCIATED COMPONENTS.
BAD
CHECK C13 AND C14 FOR LEAKAGE. CHECK Q14 AND LEAD TO PIN 8-XA1.
BAD
CHECK WAVEFORMS AT GATE OF Q12 AND Q13.
GOOD
REFER TO TABLE 4b. TROUBLESHOOT Q7 THROUGH Q11.
BAD
REFER TO SERVICE SHEET 3. TROUBLESHOOT MULTIVIBRATOR.

SERVICE SHEET 3
Input Circuits

Table 4B. Voltage Table for Variable Gain Amplifier

	Short emitter to base on Q7.				Unsolder and lift one end of A1R14 (110K) from p.c. board.		
	Q7-Q11 will assume the following voltages if they are operating properly.				Q7-Q11 will assume the following voltages if they are operating properly.		
	E	B	C		E	B	C
Q7	64 mV	64 mV	-14.66V		510 mV	0V	-13.15V
Q8	-11.82V	-14.66V	14.8V		-13.75V	-13.16V	740 mV
Q9	-11.82V	-11.22V	-11.75V		-13.75V	-15.37V	15.5V
Q10	13.79V	14.8V	-14.94V		13.88V	740 mV	15.43V
Q11	-11.07V	-11.74V	-14.94V		15.5V	15.5V	-15.43V

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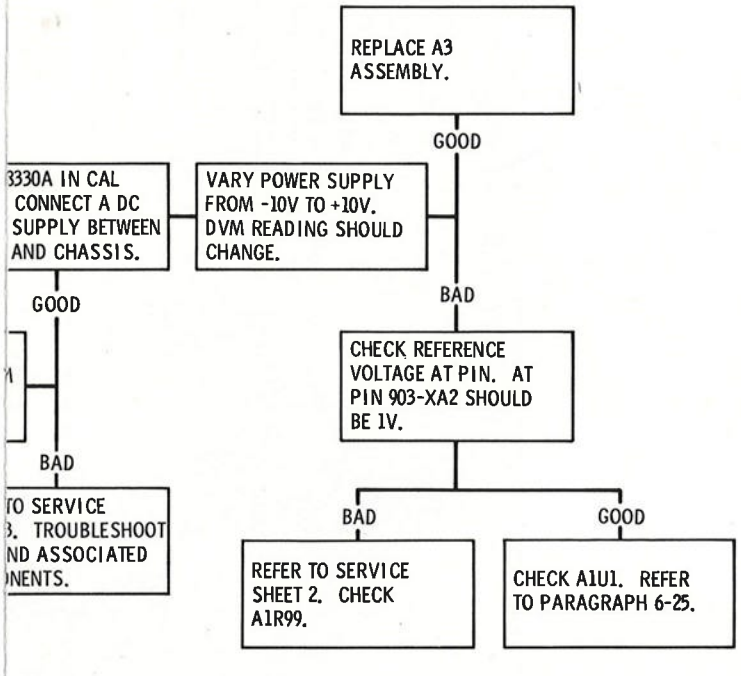

REPLACE A3 ASSEMBLY.
GOOD
3330A IN CAL CONNECT A DC SUPPLY BETWEEN AND CHASSIS.
VARY POWER SUPPLY FROM -10V TO +10V. DVM READING SHOULD CHANGE.
BAD
GOOD
CHECK REFERENCE VOLTAGE AT PIN. AT PIN 903-XA2 SHOULD BE 1V.
BAD
TO SERVICE 3. TROUBLESHOOT ND ASSOCIATED NENTS.
BAD
GOOD
REFER TO SERVICE SHEET 2. CHECK A1R99.
CHECK A1U1. REFER TO PARAGRAPH 6-25.

SERVICE SHEET 4
Variable Gain Amplifier, Synchronous Detector, and DC Amplifier

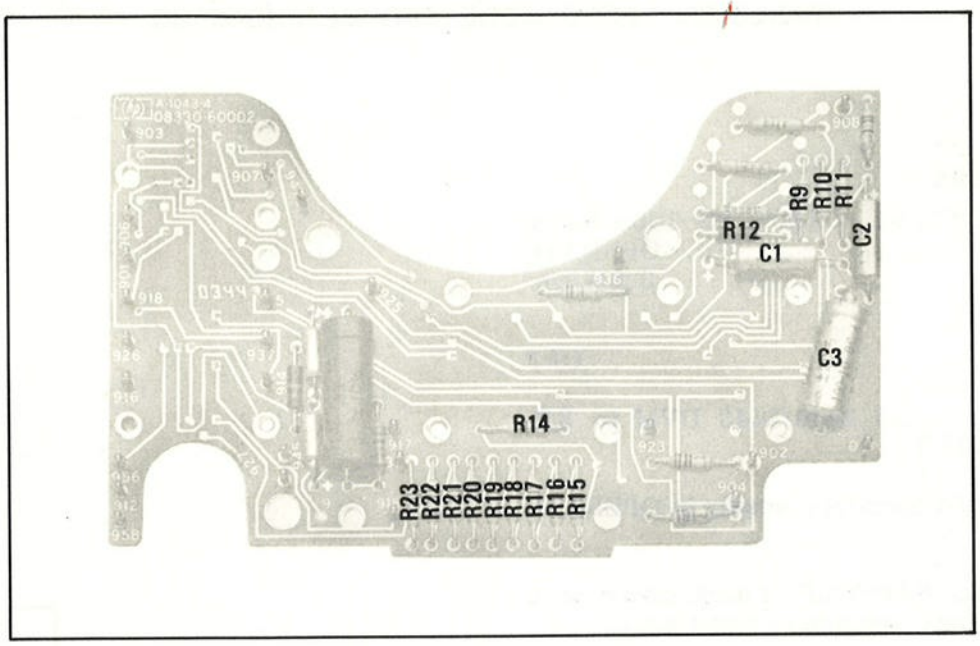


Figure 4A. A2 Switching Assembly Component Locations

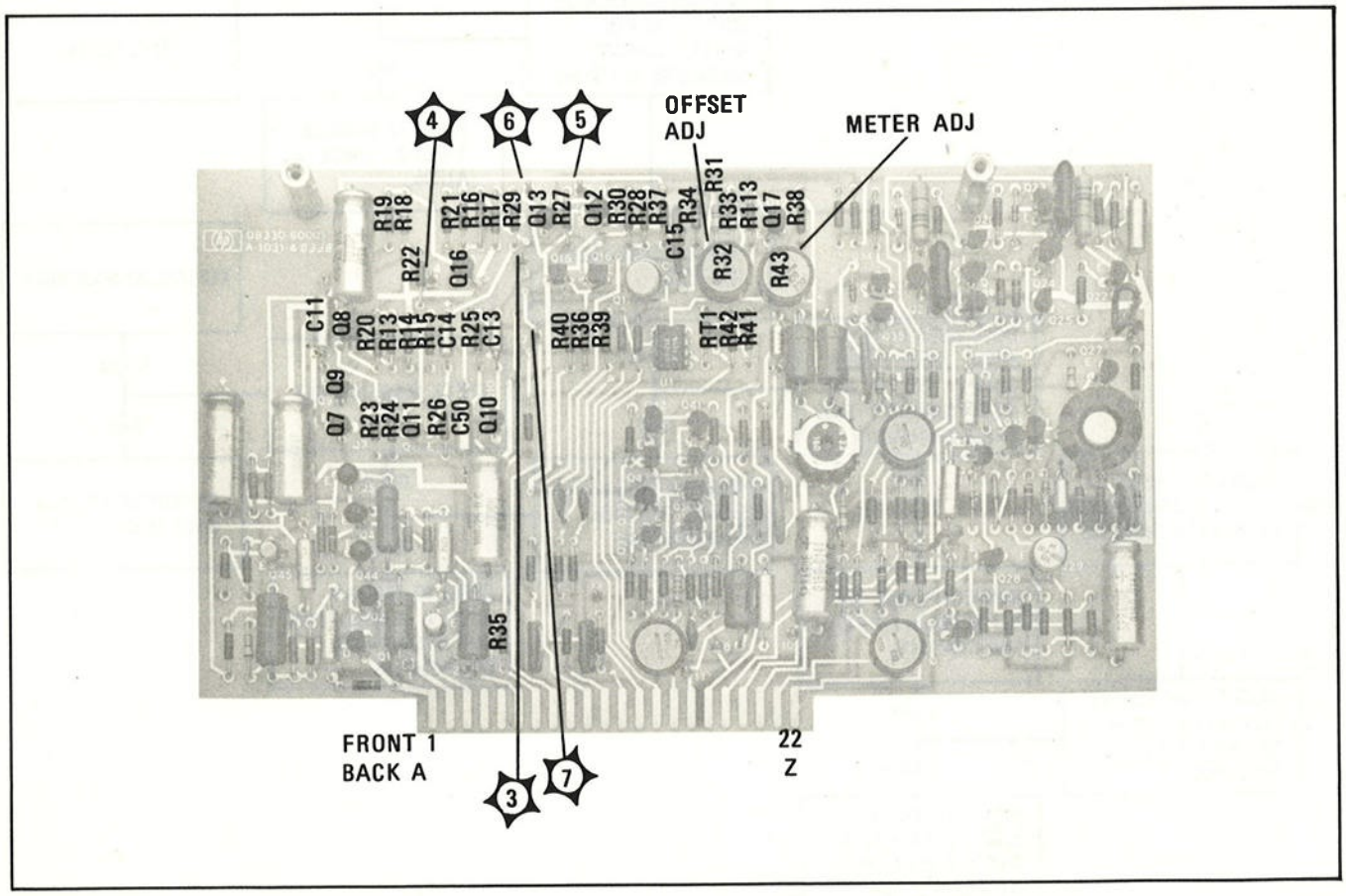
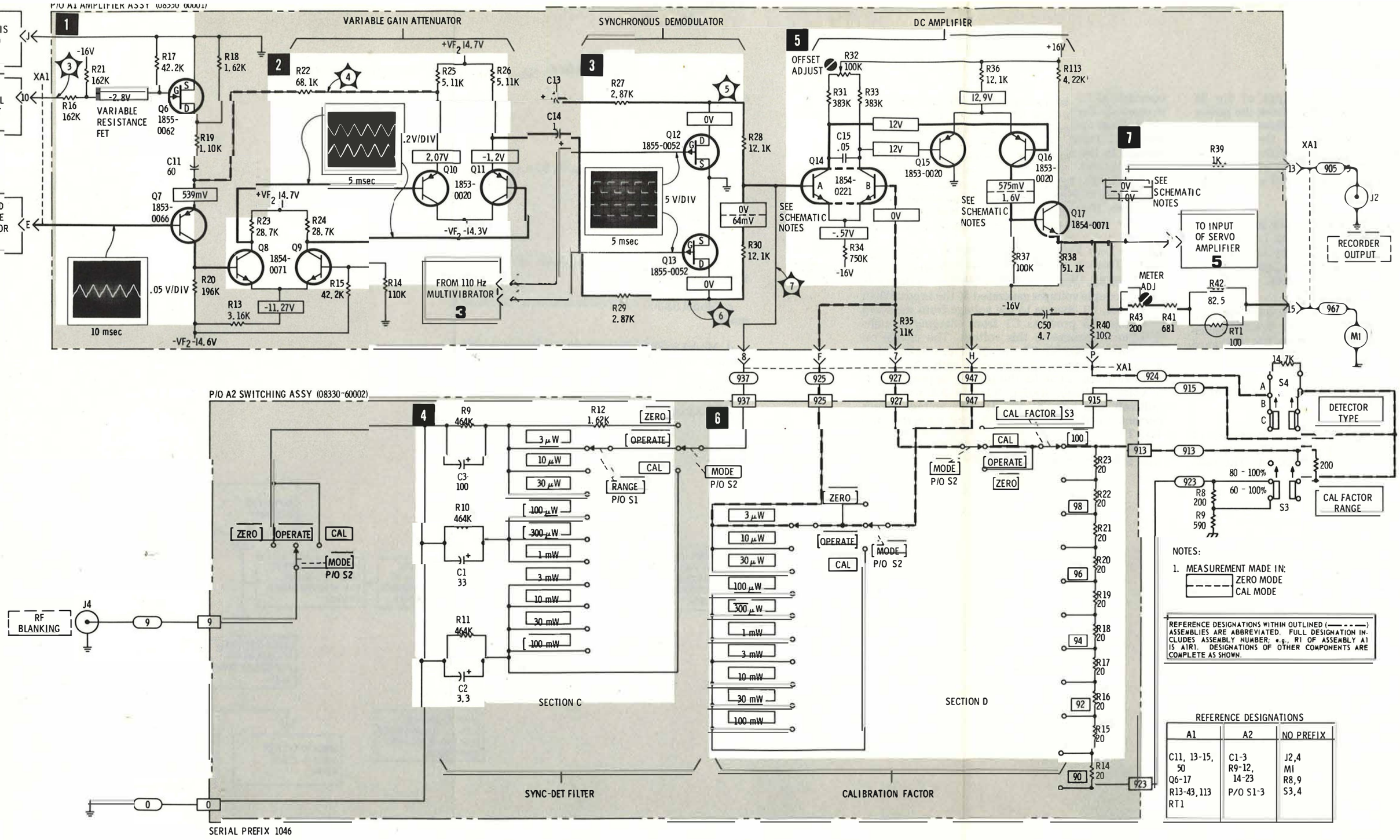


Figure 4B. A1 Amplifier Assembly Component Locations



4

Figure 4C.

Phase Splitter, Synchronous Demodulator, DC Amplifier, and Output Schematic

SERVICE SHEET 5

1 U1, an IC, compares the output of the dc amplifier with the reference voltage from the power supply. In the CAL mode, the reference voltage is 1 volt. Any difference between the reference and the dc amplifier output is amplified and used to drive the Zero/Cal circuit. Gain of the servo amplifier in the ZERO mode is 750 and 15,000 in the CAL mode.

2 Section F controls the gain of the servo amplifier through its feedback network. In the CAL mode, gain of U1 is determined by the ratio of A1R44 to R27. In the ZERO mode, gain is determined by the ratio of A1R44 to R24.

3 Section E connects the reference voltage to the servo amplifier. In the CAL mode, the reference voltage is 1 volt. In the ZERO mode, the reference voltage is zero volt.

4 Section G connects the relay driver (SS-2) to the reed relays.

5 The Cal Hold circuit controls the resistance of A1Q6 (SS-4). When K2 is closed, C2 charges to the voltage out of the servo amplifier. The time constant of C2 is approximately 30 days when K2 is opened. Each time K2 is closed, C2 charges to the voltage output of the servo amplifier. R6 prevents C2 from charging due to high-frequency changes in the voltage. CR2 limits the spikes when K2 is opened. This voltage controls the bias on MOSFET Q2. Q2 is operated in a source follower configuration with the source being about 2 volts less than the gate. The source voltage controls the gate bias on the variable resistance FET A1Q6.

6 The Zero Hold circuit is activated in the ZERO mode. This circuit establishes a correction voltage at the input (SS-3) to overcome any undesirable thermocouple voltages generated at the input. When K1 closes, C1 charges to the voltage from the servo amplifier. R5 prevents C1 from charging to high-frequency changes in this voltage. The charge on C1 biases MOSFET Q1 on. Q1 is also operated in a source follower configuration with the source following the input to the gate by approximately 2 volts. Voltage divider R3 and R2 presents a millivolt signal to R4 (SS-3). This voltage causes current to flow through R5, the detector, and R4. The voltage developed from this current flow cancels the effects of undesirable thermal voltages that might be present at the input.

TABLE 5A. CAL MODE TROUBLESHOOTING

CONDITIONS:

a. Set:

Model 8330A

CAL FACTOR %. . . 100%, 80—100% Range
MODE . . . . . OPERATE
RANGE . . . . . 3 mW/cm²

11594A

RANGE . . . . . 3 mW/cm²

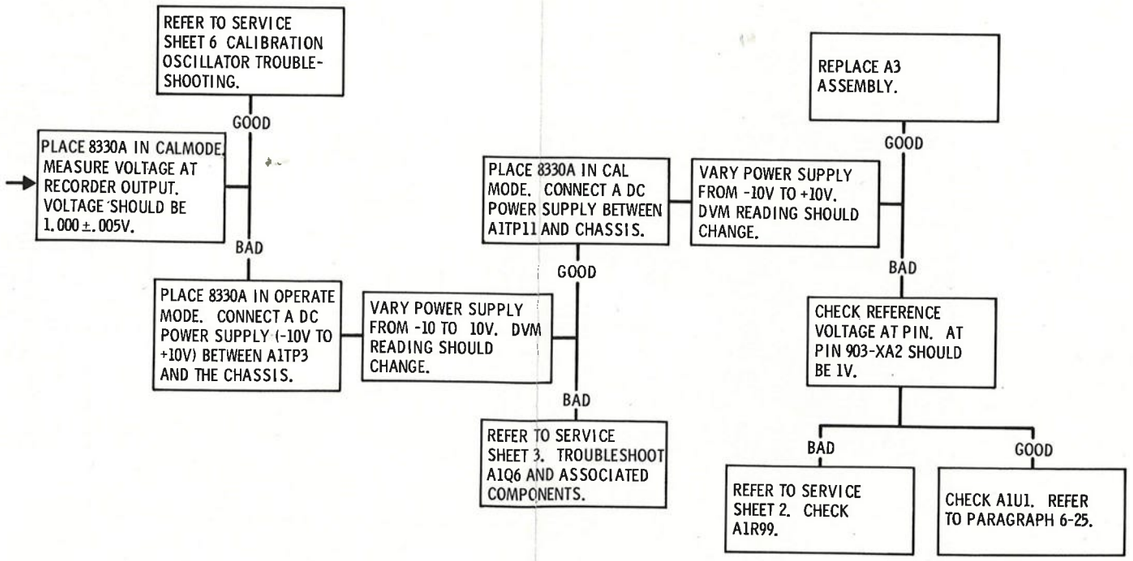
b. Connect a Model 3440/3443 DVM to the RECORDER OUTPUT.

c. Model 8330A operates normally in OPERATE mode.

d. Model 8330A functions normally with 11594A but not with 8334A.

PROBLEM:

Model 8330A not functioning in CAL mode.


REFER TO SERVICE SHEET 6 CALIBRATION OSCILLATOR TROUBLE-SHOOTING.
GOOD
PLACE 8330A IN CALMODE. MEASURE VOLTAGE AT RECORDER OUTPUT. VOLTAGE SHOULD BE 1.000 ±.005V.
BAD
PLACE 8330A IN OPERATE MODE. CONNECT A DC POWER SUPPLY (-10V TO +10V) BETWEEN A1TP3 AND THE CHASSIS.
VARY POWER SUPPLY FROM -10 TO 10V. DVM READING SHOULD CHANGE.
GOOD
BAD
REFER TO SERVICE SHEET 3. TROUBLESHOOT A1Q6 AND ASSOCIATED COMPONENTS.
PLACE 8330A IN CAL MODE. CONNECT A DC POWER SUPPLY BETWEEN A1TP11 AND CHASSIS.
VARY POWER SUPPLY FROM -10V TO +10V. DVM READING SHOULD CHANGE.
GOOD
BAD
CHECK REFERENCE VOLTAGE AT PIN. AT PIN 903-XA2 SHOULD BE 1V.
BAD
GOOD
REFER TO SERVICE SHEET 2. CHECK A1R99.
CHECK A1U1. REFER TO PARAGRAPH 6-25.
REPLACE A3 ASSEMBLY.
GOOD

SERVICE SHEET 4

Variable Gain Amplifier, Synchronous Detector, and DC Amplifier

TABLE 5B. ZERO MODE TROUBLESHOOTING

CONDITIONS:

a. Set:

Model 8330A

CAL FACTOR %. . . 100%, 80—100% Range
MODE . . . . . OPERATE
RANGE . . . . . 3 $\mu W/cm^2$

11594A

RANGE . . . . . OFF

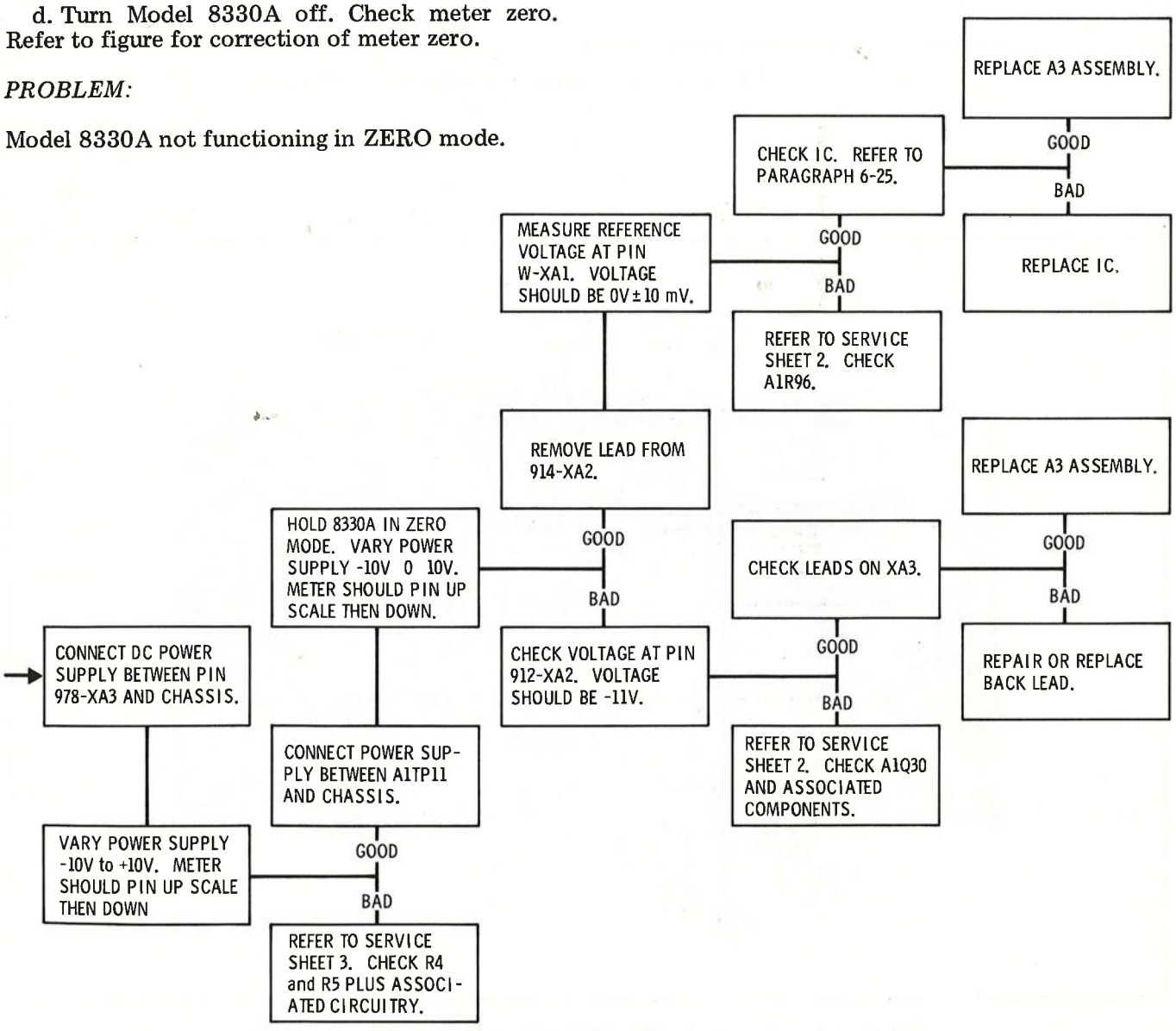
b. Connect a Model 3440/3443 DVM to RECORDER OUTPUT.

c. Model 8330A operates normally in OPERATE mode.

d. Turn Model 8330A off. Check meter zero. Refer to figure for correction of meter zero.

PROBLEM:

Model 8330A not functioning in ZERO mode.


CONNECT DC POWER SUPPLY BETWEEN PIN 978-XA3 AND CHASSIS.
VARY POWER SUPPLY -10V to +10V. METER SHOULD PIN UP SCALE THEN DOWN
GOOD
BAD
REFER TO SERVICE SHEET 3. CHECK R4 and R5 PLUS ASSOCIATED CIRCUITRY.
CONNECT POWER SUPPLY BETWEEN A1TP11 AND CHASSIS.
HOLD 8330A IN ZERO MODE. VARY POWER SUPPLY -10V 0 10V. METER SHOULD PIN UP SCALE THEN DOWN.
GOOD
BAD
REMOVE LEAD FROM 914-XA2.
MEASURE REFERENCE VOLTAGE AT PIN W-XA1. VOLTAGE SHOULD BE 0V ± 10 mV.
GOOD
BAD
CHECK VOLTAGE AT PIN 912-XA2. VOLTAGE SHOULD BE -11V.
GOOD
BAD
REFER TO SERVICE SHEET 2. CHECK A1R96.
CHECK IC. REFER TO PARAGRAPH 6-25.
GOOD
BAD
REPLACE IC.
REPLACE A3 ASSEMBLY.
CHECK LEADS ON XA3.
GOOD
BAD
REFER TO SERVICE SHEET 2. CHECK A1Q30 AND ASSOCIATED COMPONENTS.
GOOD
BAD
REPAIR OR REPLACE BACK LEAD.
REPLACE A3 ASSEMBLY.

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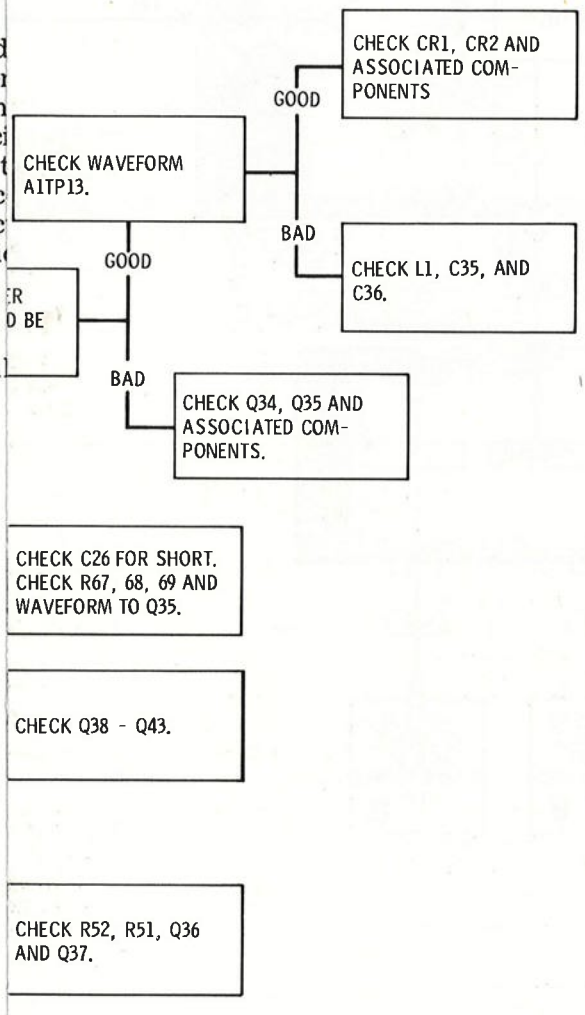

CHECK CR1, CR2 AND ASSOCIATED COMPONENTS
GOOD
CHECK WAVEFORM A1TP13.
BAD
CHECK L1, C35, AND C36.
GOOD
BAD
CHECK Q34, Q35 AND ASSOCIATED COMPONENTS.
CHECK C26 FOR SHORT. CHECK R67, 68, 69 AND WAVEFORM TO Q35.
CHECK Q38 - Q43.
CHECK R52, R51, Q36 AND Q37.

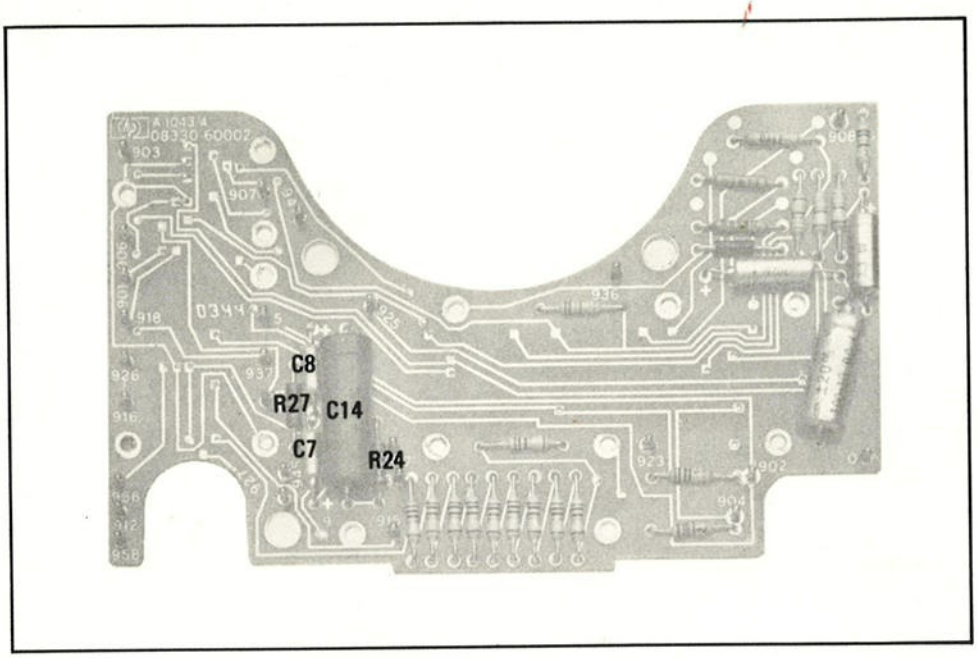


Figure 5A. A2 Switching Assembly Component Locations

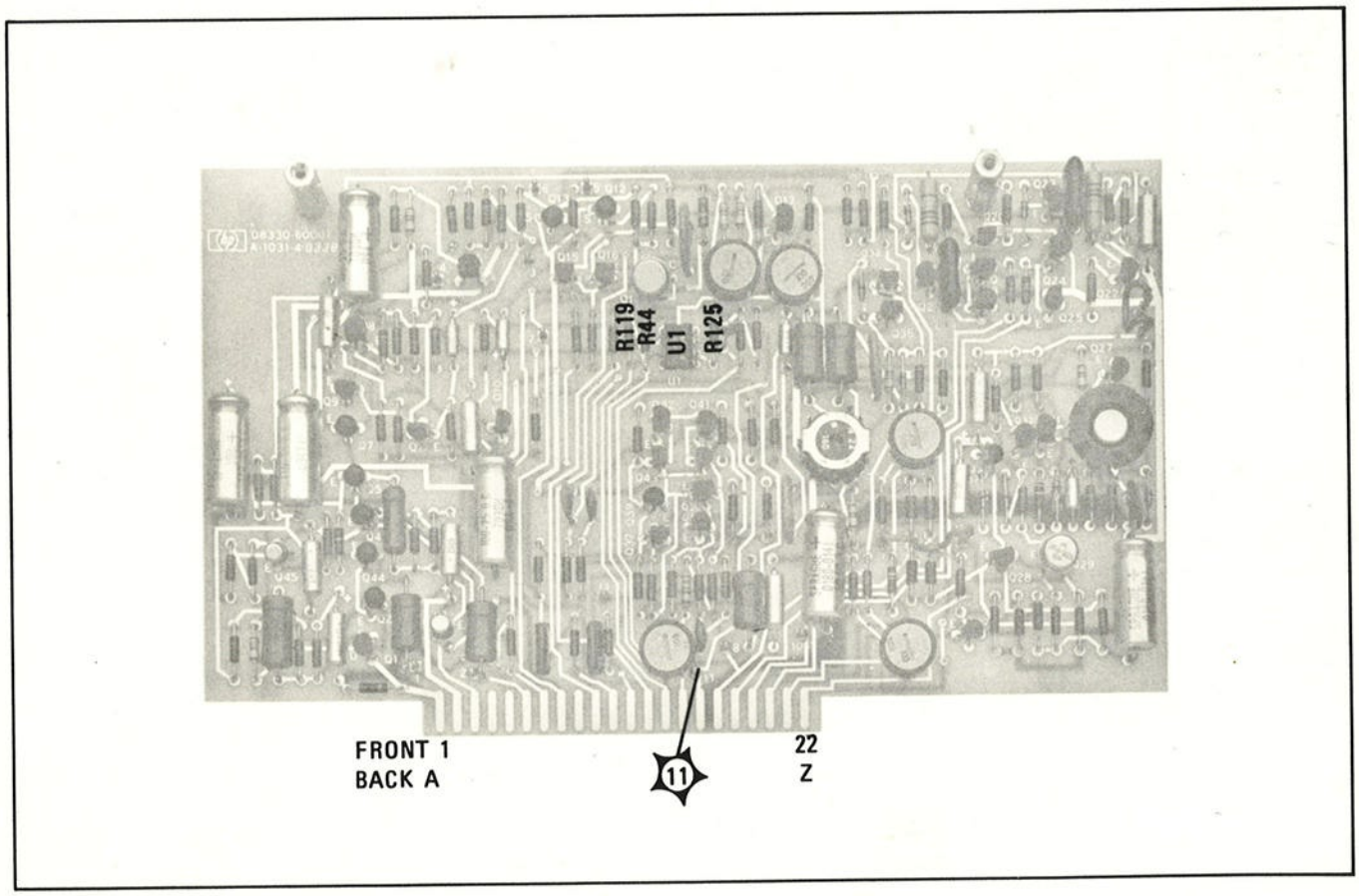
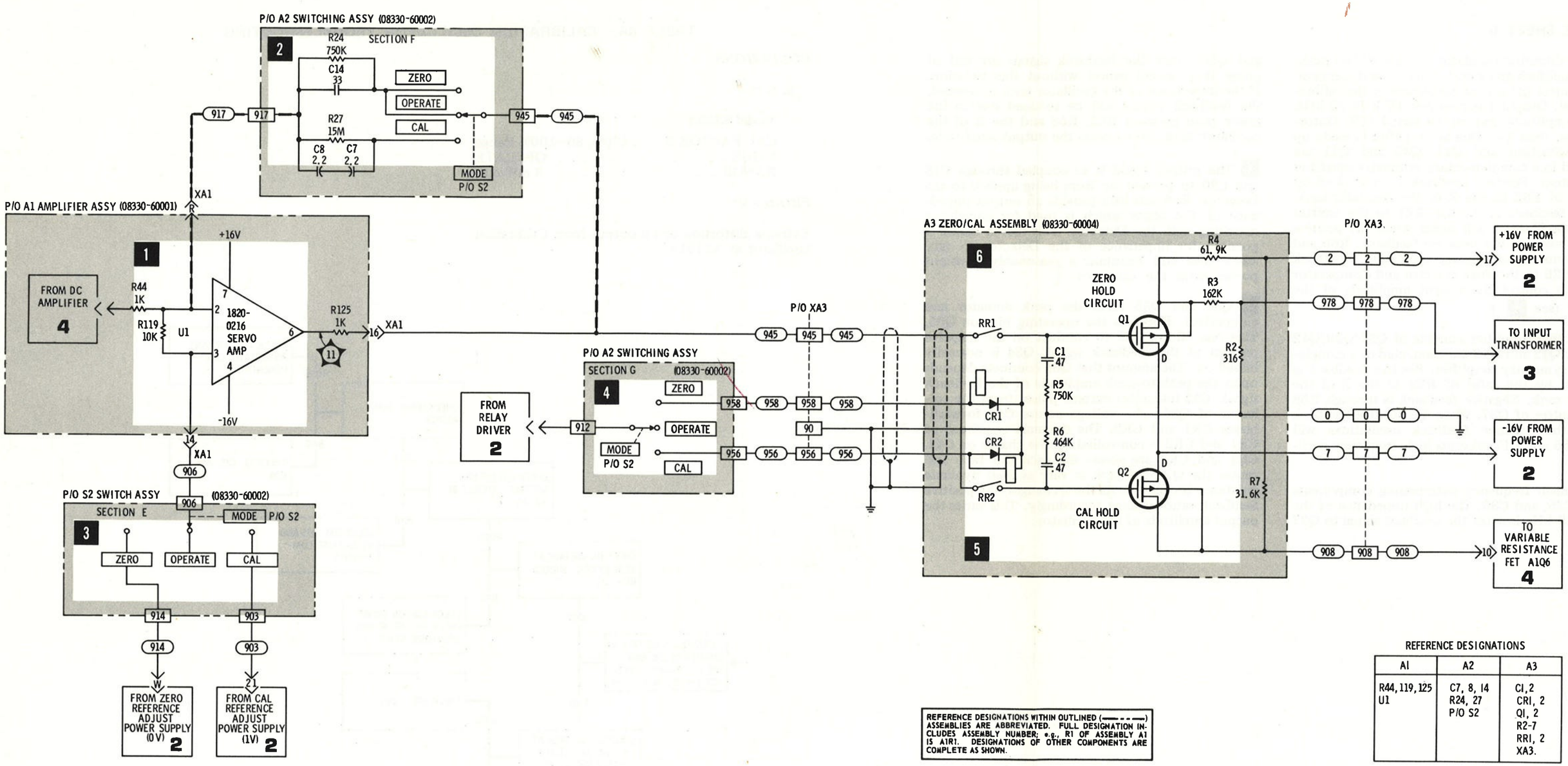


Figure 5B. A1 Amplifier Assembly Component Locations



SERIAL PREFIX 1046

REFERENCE DESIGNATIONS WITHIN OUTLINED (— - - —) ASSEMBLIES ARE ABBREVIATED. FULL DESIGNATION INCLUDES ASSEMBLY NUMBER; e.g., R1 OF ASSEMBLY A1 IS A1R1. DESIGNATIONS OF OTHER COMPONENTS ARE COMPLETE AS SHOWN.

REFERENCE DESIGNATIONS

A1	A2	A3
R44, 119, 125 U1	C7, 8, 14 R24, 27 P/O S2	C1, 2 CR1, 2 Q1, 2 R2-7 RR1, 2 XA3.

5

Figure 5C. Servo Amplifier and Zero/Cal Schematic

SERVICE SHEET 6

1 The calibration oscillator consists of two push-pull ac amplifiers and a peak detector and comparator to control the output amplitude of the calibration signal. Output frequency is 10 kHz ±3 kHz, with an amplitude that can be varied ±5%. Distortion is less than 1%. One ac amplifier is made up of Q36/Q38/Q40 and Q41. Q40 and Q41 are connected in a complementary symmetry amplifier configuration. Positive feedback is controlled by the ratio of R62 to the Z of the oscillator tank. Negative feedback is through R61 to the emitter of Q36. Oscillations will occur when the positive feedback exceeds the negative feedback. R65 and C21 prevents high-frequency oscillation. Feedback through C26 to the Peak detector and Comparator is used to control the output amplitude of the oscillator (see 5 .)

2 The other amplifier consists of Q37/Q39/Q42 and Q43. Q42 and Q43 are connected as a complementary symmetry amplifier. Positive feedback is controlled by the ratio of R59 to the Z of the oscillator tank. Negative feedback is through R58 to the emitter of Q37. When the positive feedback exceeds the negative feedback oscillations will occur. R55 and C17 prevents high-frequency oscillations.

3 The main frequency determining components are L1, C35, and C36. The high impedance of the tank at 10 kHz isolates the feedback signal to Q37 and Q36. Since the feedback signals are out of phase they would cancel without this isolation. If the impedance of the oscillator tank is lowered, the feedback signals will be reduced due to the lower ratio between R62, R58 and the Z of the oscillator tank. This lowers the output amplitude.

4 The output signal is ac coupled through C18 and C20 to prevent dc from being applied to the Detector. R56 and R63 provide an output impedance of 474 ohms which is used for impedance matching with the Detector. This match makes it possible for impedance of the Detector to vary ±20% and still maintain a reasonably constant power from the oscillator.

5 Q34 and Q35 form the peak detector and comparator. R68 sets the operating bias on Q35. This bias allows Q35 to conduct on the negative portion of the feedback signal. Q34 is normally biased on. The amount that Q35 conducts depends upon the peak-to-peak amplitude of the feedback signal. C42 integrates current pulses from the collector of Q35. The voltage across C42 forward-biases CR1 and CR2. The dynamic resistance of CR1 and CR2 is controlled by the charge on C42. CR1 and CR2 are across the oscillator tank and causes the Q of the tank to vary as their dynamic resistance is changed. As the Q changes, the positive feedback ratios change accordingly. This varies the output amplitude of the oscillator.

TABLE 6A. CALIBRATION OSCILLATOR TROUBLESHOOTING

CONDITIONS:

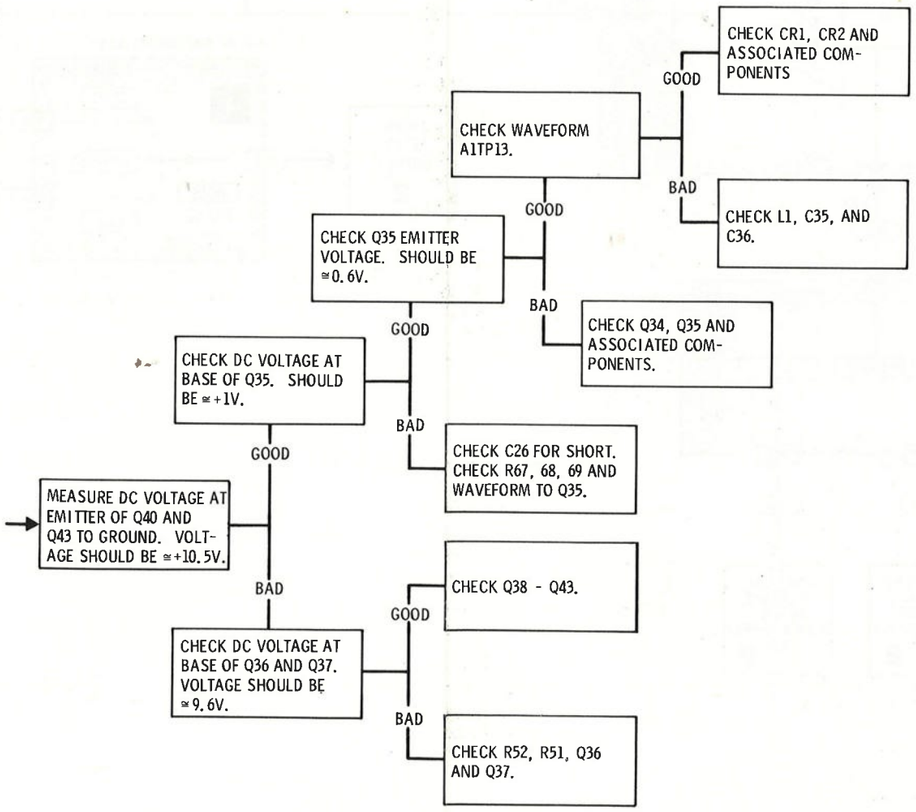
a. Set:

Model 8330A

CAL FACTOR %. . . 100%, 80—100% Range
MODE . . . . . OPERATE
RANGE . . . . . 3 mW/cm^2

PROBLEM:

Extreme distortion or no output from Calibration Oscillator at A1TP13.


MEASURE DC VOLTAGE AT EMITTER OF Q40 AND Q43 TO GROUND. VOLTAGE SHOULD BE ≅+10.5V.
GOOD
CHECK DC VOLTAGE AT BASE OF Q35. SHOULD BE ≅+1V.
GOOD
CHECK Q35 EMITTER VOLTAGE. SHOULD BE ≅0.6V.
GOOD
CHECK WAVEFORM A1TP13.
GOOD
CHECK R67, R68, R69 AND WAVEFORM TO Q35.
BAD
CHECK C26 FOR SHORT.
BAD
CHECK Q34, Q35 AND ASSOCIATED COMPONENTS.
BAD
CHECK L1, C35, AND C36.
BAD
CHECK CR1, CR2 AND ASSOCIATED COMPONENTS
BAD
CHECK DC VOLTAGE AT BASE OF Q36 AND Q37. VOLTAGE SHOULD BE ≅9.6V.
GOOD
CHECK Q38 - Q43.
BAD
CHECK R52, R51, Q36 AND Q37.

SERVICE SHEET 6

Calibration Oscillator

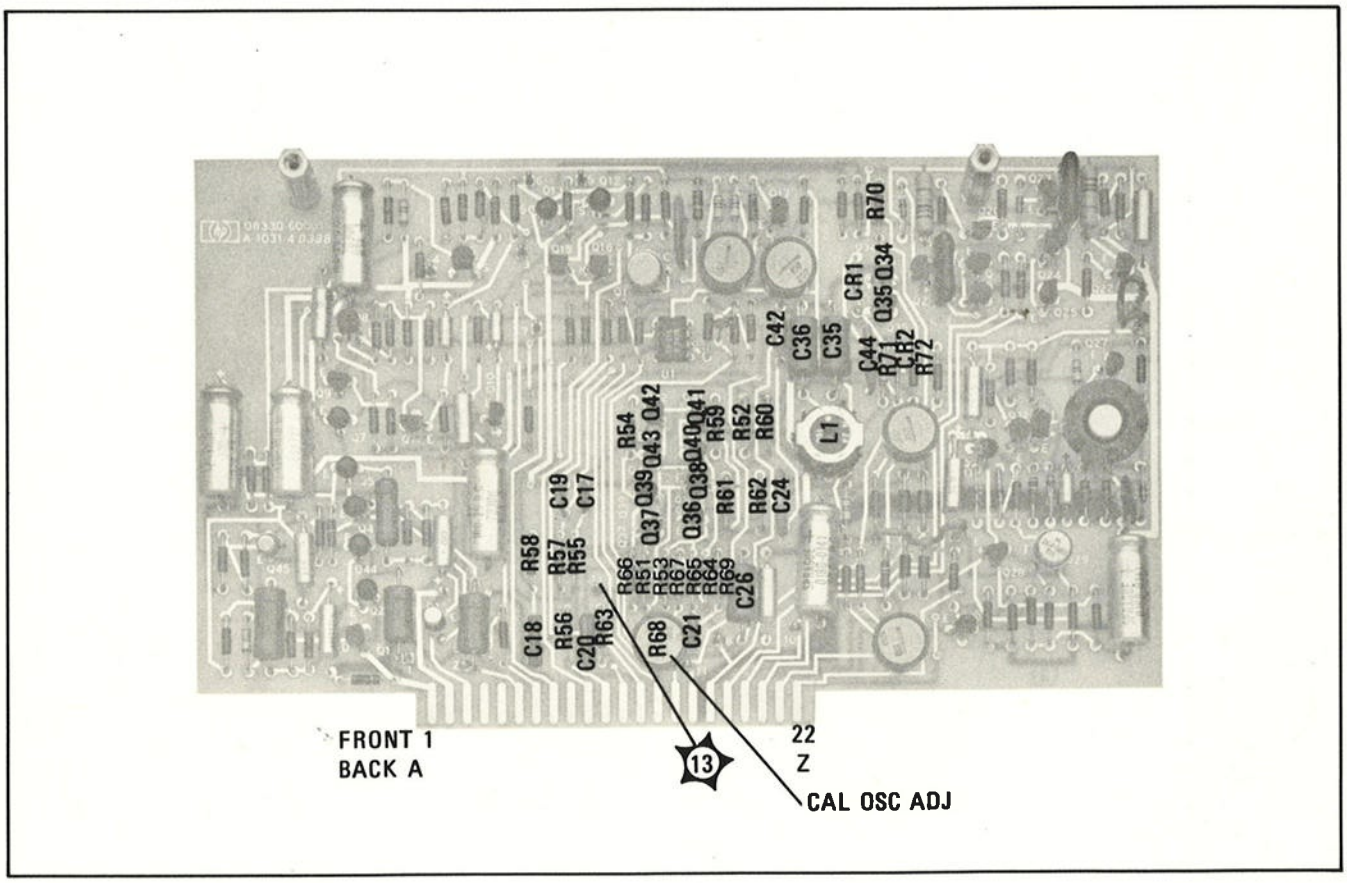
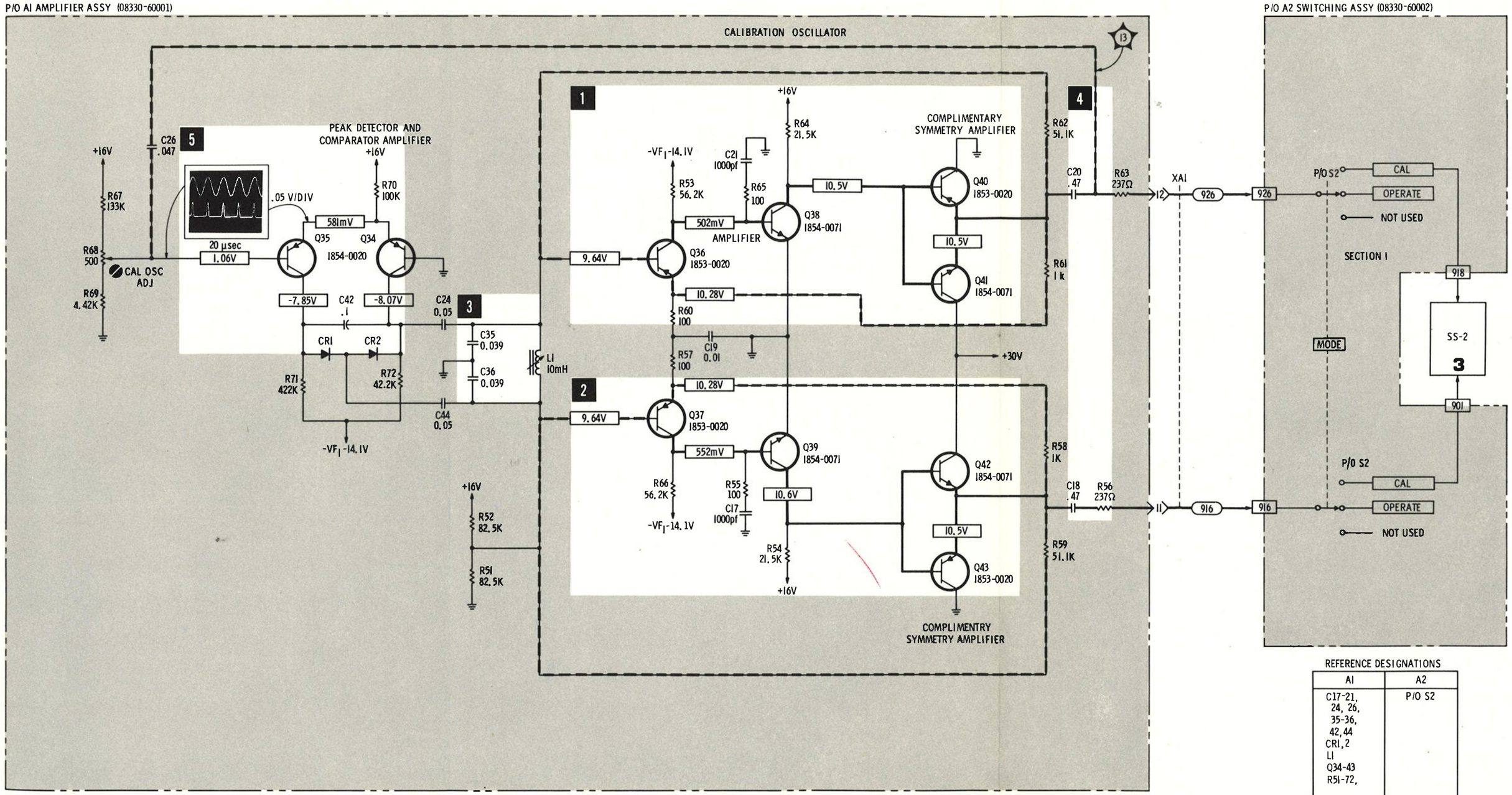


Figure 6A. A1 Amplifier Assembly Component Locations



REFERENCE DESIGNATIONS

A1	A2
C17-21, 24, 26, 35-36, 42, 44 CR1, 2 L1 Q34-43 R51-72,	P/O S2

6

Figure 6B. Calibration Oscillator Schematic

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E 11-70

SPECIAL NOTES TO USER
READ CAREFULLY

PLEASE READ THE FOLLOWING REMARKS CAREFULLY BEFORE ATTEMPTING TO USE THE MODEL 8330A/8334A RADIANT FLUX METER SYSTEM.

1

DRIFT PRECAUTIONS Thermopile detectors are inherently temperature sensitive devices. Although design steps have been taken to minimize effects due to handling of the detector, *FOR MINIMUM DRIFT ON THE MOST SENSITIVE RANGES, DO NOT HANDLE THE DETECTOR OR PLACE THE DETECTOR IN A DIFFERENT AMBIENT TEMPERATURE ENVIRONMENT IMMEDIATELY PRIOR TO PERFORMING MEASUREMENTS.* In addition, do not attempt to make sensitive measurements immediately after utilizing the built-in electronic calibration system (Auto-Cal) of the Model 8330A.

2

The device used to exclude radiation from the detector during ZERO and CAL modes of operation must be non-transmitting (opaque) *throughout the spectral range to which the detector is sensitive*. In addition, the device should be at nearly the same temperature as the detector element itself to minimize self-emission effects. Camera-type shutters are particularly useful in this application and can be remotely controlled.

3

Do not attempt to utilize the most sensitive ranges for a period of 5 to 10 min after electronic calibration to permit accumulated heat energy to dissipate from thermopile.

4

Because the detector is sensitive to a broad spectral range of wavelengths, precautions should be observed during measurements to exclude extraneous radiation by using spectral filters and/or geometrical shields.

Also, it should be noted that any object in the field-of-view of the detector emits blackbody-like radiation (the wavelength and intensity of which depends on its temperature). If the temperature of certain objects is significantly *different* from the temperature of the detector element, *a net transfer of radiation energy* (background) *will occur that can cause erroneous* readings. Infrared-blocking filters can sometimes be used to eliminate this problem when background-radiation producing objects cannot be removed from the field-of-view of the detector or cannot be zeroed out of the measurement.

5

The CAL FACTOR marked on any particular Model 8334A can be between 60% and 100%. Since the range of the front-panel CAL FACTOR switch of the 8330A is limited to the 80% to 100% range, a rear panel CAL FACTOR RANGE switch is provided to translate range to 60%–80%. Thus when the CAL FACTOR RANGE switch is in the alternate "60%–80%" position, the 80% position marked on the front panel becomes 60%, the 100% position becomes 80%, and all intermediate steps are likewise adjusted as shown below

80 • 84 • 88 • 92 • 96 • 100	80% – 100% position
60 • 64 • 68 • 72 • 76 • 80	60% – 80% position

Be certain the switches are in the correct position for the particular Model 8334A in use.

HEWLETT hp PACKARD

RADIANT FLUX METER

MODEL
8330A

UPDATING SUPPLEMENT

November 1972

MANUAL PRINTED: August 1971

MANUAL PART NUMBER: 08330-90002

SUPPLEMENT DESCRIPTION: **The purpose of this supplement is to correct manual errors, to describe differences between the instrument described in the manual and the instrument supplied, and to provide additional operating and service information as required.**

ITEM	DESCRIPTION
1.	Page 5-6. Delete S1, HP Part No. 3103-1602 SW Toggle. Add S1, HP Part No. 3101-1258. amd 3101-1252 Lever Insl.
2.	Page 5-5. A1R68 is R:VAR WW 200Ω 5% type H 1W should be R: var WW 500Ω 5% type H 1W. Page 5-5. A1R69 is 0698-3155, 4.64 KΩ should be 0698-4442, 4.42 KΩ. Page 5-6. A2R12 is 0698-3153, 3.83 K should be 0757-0428 1.61 K. Page 5-6. R1 is 0757-0401, 100Ω 1/8 should be same value 1/2 W. R2 is 0757-0198, 100Ω 1/8W should be same value 1/2 W.
3.	Page 6-13, Figure 3C. Output of Q20 Collector (R115) to G of Q12, Q22 Collector (R116) to G of Q13. Voltage at collector of Q4 should be -1.71V. Page 6-19, Figure 6B, Q35, and Q36 are 1854-0020 should be 1853-0020. Page 6-13. R76 and R81 go to + VF_1 the power input should be + VF_3. Page 6-15. Schematic labelled incorrectly CAL factor S. W. is 100→ 90 on every outer contact S. B. 100→80 using each contact in 2% increments.

ITEM DESCRIPTION

4. The Replaceable Parts, Table 5-2, Page 5-6 List should be corrected as follows:

REF DESIGNATOR	DESCRIPTION/FUNCTION	HP STOCK NO.
S2	Voltage, 115/230	3101-1234
S3	CAL Factor, 8-100/60-80	3101-0070
S4	Detector A/B/C	3101-0903

5. Page 6-8. Table 1A, A1TP2 is .25V RMS
A1TP1 is .66V RMS
A1TP8 is +16.5V
A1 TP10 should be .5V/DIV

Page 6-12. Table 3B, A1TP2 is .25V
Figure 3C TP10 should be .5V/DIV

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